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BOEING

NATO: A BUSINESS HISTORY

Volume II of three

by Robert R. Foxcurran

1986 revision

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PART II

INTRODUCTION

In the area of weapon systems, the various institutionalized arrangements prior to 1966 were unsuccessful. Since 1966, NATO has settled for a lower profile, i.e., serving as an information and coordination conduit for ad hoc collaboration at the transnational (nation-to-nation) level. As emphasized by Vandevanter in his 1964 Rand study, the lesson learned from the institutionalized approaches of the 1950's and early '60s was that NATO's chief task should be that of a middle-man and catalyst, not a director and judge. In this area, faced with the worsening cost/budget squeeze, the alternative has not been Alliance-wide, but transnational projects. Collaboration will most certainly continue along this line, be it through ad hoc arrangements reached through, or independently of, NATO's institutions and procedures.

In this part of the paper, Part II, ad hoc collaboration in systems development and/or production at the transnational level is classified into 8 modes on the basis of several key variables. These variables are:

- Whether the collaboration involves development and/or production.

- The nature of business relationship at the industrial level (i.e., part of a transnational venture, licensing on a bilateral basis, or a barter arrangement involving subcontracting and/or some sort of external offset.)

- Whether one or more than one nation is collaborating with the U.S. on the European end.

- The U.S.-European relationship and the direction of the flow of technology across the Atlantic -- distinguishing between the U.S. and Europe on the basis of the size of the domestic market and the domestic industrial basis, national competition and export policies, world role, and financial industrial, and technological resources, etc.

- Differentiating between the medium powers (France, the FRG and the U.K.) and the smaller European national economies on the basis of their financial, industrial and technological resources.

These 8 modes are:

(1) License production in one European nation;

(2) License production in Europe by a multinational consortium of a system developed in the U.S.;

(3) Joint development and production among European nations;

(4) License production in the U.S. of a system developed in Europe;

(5) Transatlantic joint development;

(6) Bi-lateral offset arrangements for the purchase of a foreign system;

(7) Transatlantic joint production (or systems management) by a U.S.-led industrial team (i.e., involving no significant joint development); and

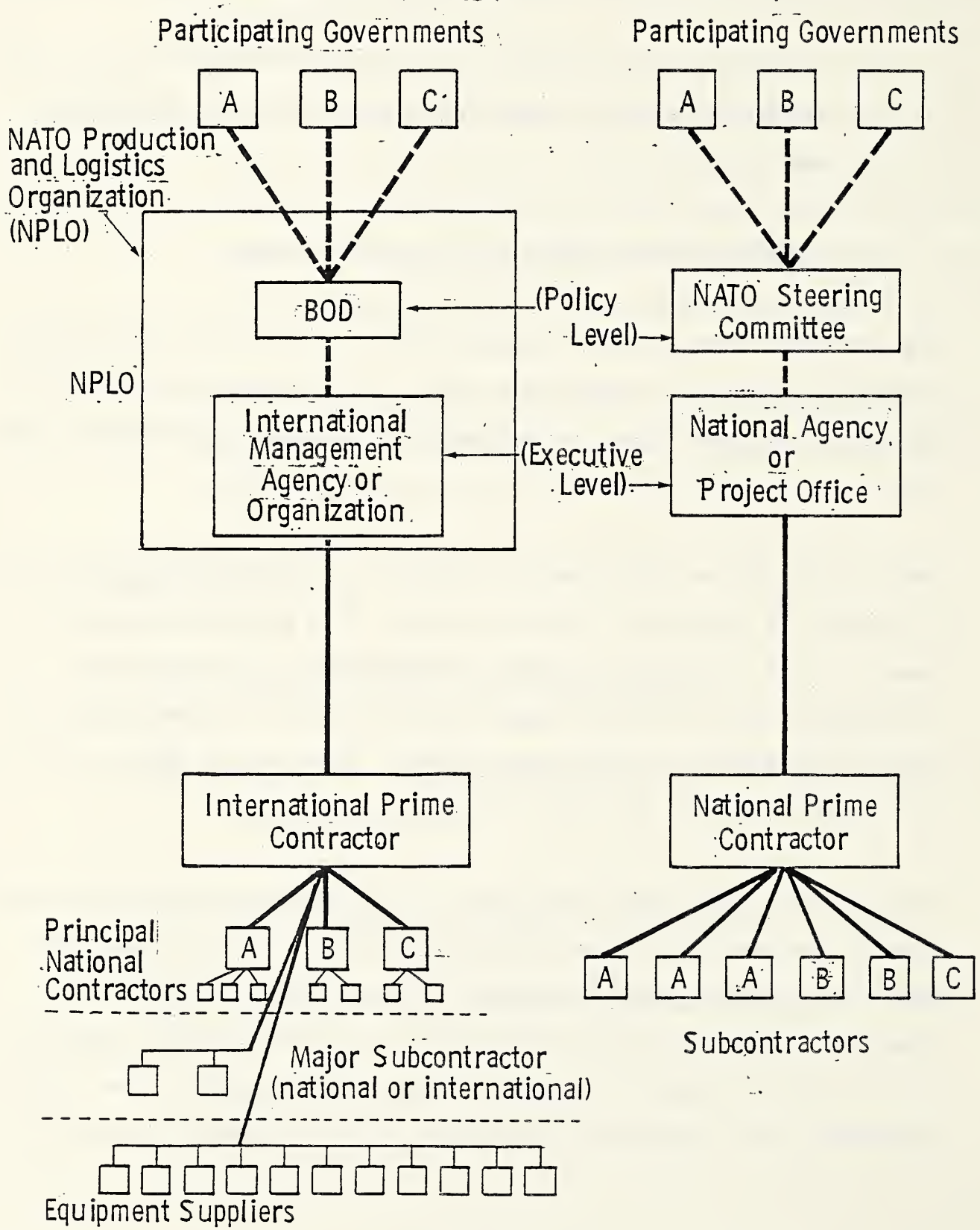
(8) Package Deals and the "Family of Weapons" concept.

These 8 modes, though obviously somewhat arbitrary as with any categorization, provided a framework for grouping the various inter-allied projects, as well as giving one a clearer idea of the development of inter-allied collaboration over time.

Before going into the eight Modes of industrial collaboration, the distinguishing factors of which are all industry oriented, it is worth pointing out the general nature of the several types of intergovernmental and contractual arrangements utilized. We will take a more detailed look at these intergovernmental arrangements in the individual projects. These are not however one of the key variables on which the 8 Modes are based.

Those ad hoc projects where the customers (i.e., the governments) participates in project management with industry (which has been increasingly the case) are governed by intergovernmental agreements. These agreements are between the executive branches of 2 or more governments and provide the overall framework within which the project is managed by industry and government. These executive agreements (i.e., between executive branches of the governments) are variously

NATO PROJECT MANAGEMENT AND CONTRACTING



termed technical agreements, protocols, or more currently, memoranda of understanding (MOUs). For the implementation of these intergovernmental agreements for 'NATO' weapon projects (i.e., in those cases where governments are direct participants) the ad hoc governmental groupings usually set up:

(1) A multinational procurement agency, an NPLO with its Policy Board and International Management Agency, such as the:

- NATO Hawk Production and Logistics Organization (NHPLO);
- NATO Starfighter Production Organization (NASPO);
- NATO Air Defense Ground Environment (NADGE) Organization;
- NATO MRCA Management Organization (NAMMO);
- NATO AEW&C Project Management Organization (NAPMO).

(2) An international Steering Committee,[1] involving no new procurement agency, but instead relying on one of the participating nations to perform the procurement functions on behalf of the other participants, be it with multinational staffing of the project office. For example:

- The NATO Atlantic Maritime Patrol Aircraft Steering Committee and France's Direction Technique des Constructions Aeronautiques (DTCA);
- The NATO Seasparrow Surface Missile System Steering Committee and the USN's Naval Sea Systems Command;
- The NATO PHM Hydrofoil Steering Committee and the USN's Naval Sea Systems Command;

- The NATO Tri-Partitite Minehunter Steering Committee and France's Direction Technique des Constructions Navales (DTCN);
- The Alpha Jet Steering Committee and France's DTCA:
- The F-16 Steering Committee and the USAF's Aeronautical Systems Division.

These Steering Committees are either NATO Project Steering Committees for one project, and/or permanent multi-project steering groups such as the Anglo-French Projects Group and the Franco-German Program Office (BPFA).[2]

In the case of the Project Steering Committee approach, a national procurement agency - with some representation from other participants for NATO Projects - remains under the international supervision of the Steering Committee. It follows its own national procurement laws and regulations, although certain national practices can be waived through intergovernmental negotiations. This closely parallels the normal NATO Infrastructure Program's international Committee—national procurement authority relationship. For the participating nations logistics support usually involves either a break up into purely national logistics efforts, or plugging into the dominant nation's logistics system.

For the NPLO's, although NATO has produced regulations[3] and guidelines[4] - including the organization of the procurement authority, boiler plate clauses, as well as those somewhat peculiar to NATO contracting, as regarding codification, quality assurance, rights to intellectual/industrial property resulting from NATO funded R&D, disputes procedures, tax and tariff exemptions, etc. - it is the NPLO's ad hoc membership who drafts and implements their own set of

NATO Project Management and Contracting

The Evolution of the Organization and Status of NATO's subsidiary agencies (1954-62) NATO Production and Logistics Organization (NPLO's)		NATO Projects relying solely on existing national agencies	
(1954-7)	Initial adjustment in attitudes required for first civil subsidiary to be established. The Central European Operating Authority (CEOA) for the pipeline system	(1950-58)	NATO Infrastructure Program's exclusive dependence on national agencies for contracting and project management while under the international supervision of NATO's Payments and Progress Committee until ACE-High project
(1958)	SHAPE becomes NATO's 16th host nation for the NATO Infrastructure Program's ACE-High project		
(1958-60)	NATO Hawk Project Office (NHPO), NATO's first weapon system program management office impasse over supranationality so a set of parallel contracts signed	(1959)	NATO Atlantic Maritime Patrol Aircraft Project A Project Steering Committee with representatives of five participating nations oversees project which is implemented by France's Direction Technique et Industrielle de l'Aeronautique (DTIA)
(1960-62)	Experience with: NATO Hawk Sidewinder, F-1046, Bullpup and several other project offices; NAMSO with Maintenance and Supply; and the Supranational authority of the EEC		
(1962)	A Model Charter for NPLO's is promulgated, NATO Document, C-M(62)18, entitled "Regulations for NATO production and Logistics Organizations" - Contract authority is finally granted to NATO's civil subsidiaries NPLO's are used for only one project, or on a functional or multiproject basis. NPLO's are involved in Infrastructure, Logistics and Weapon systems projects. NPLO's rely as well on national agencies to perform certain functions. Though ad hoc grouping of 2 or more states make up the regulations and procedures governing any given procurement, AC/94 also issued in 1974 the following NATO Document AC/259-D/374, AC/94-D/244, entitled "Guidance to NATO Procurement Authorities".	(1965)	Binational Multiproject framework Anglo-French Projects Committee Franco-German Project Office

arrangements. When production is completed, the NPLO's usually transfer logistics support functions to a special NPLO, the NATO Maintenance and Supply Organization (NAMSO).

On the industrial side, usually, though not always, a parallel pattern is followed: (1) the participating firms either set up an international company (under a given national law), spanning the full range from shell companies such as Hawk and Jaguar, to those having intergrated management tasks such as the MRCA; or (2) one participating firm serves as prime contractor (Sidewinder AIM-9L, AWACS, F-16) subcontracting to the others—or some combination of the two as in the Atlantic Maritime Patrol Aircraft.

CHAPTER 6

MODE #1

LICENSED PRODUCTION IN ONE EUROPEAN NATION OF A SYSTEM DEVELOPED IN THE U.S. OR ELSEWHERE IN EUROPE

Beginning with the Western European Defense Organization[1] in 1949, and its sponsoring of the production under license of British aircraft and engines in France, Belgium, and the Netherlands, the web of interlocking licensing agreements at both the system and subsystem levels among NATO nations has become an increasingly dense one. This network of arrangements gradually expanded to include the seven other Modes treated in this paper. Though, to the regret of many, this relationship has evolved along cooperative lines (i.e., industrial and governmental consortia for a given project or set of projects) instead of along the integrated lines envisioned in the Alliance's earlier years, the cooperative arrangements utilized for such projects have now come to represent a new area of the art of management, involving both business and government.

A. INTRODUCTION

Bilateral licensing agreements have long been a standard mechanism for arms transfer dating back into history to the more primitive levels of technology. Not only is this the classic Mode of collaboration (with the possible exception of Mode #6 which, at its core is even more primitive, being a modern variation of the barter system), but it was also the most extensively used Mode among NATO members into the 1960's.

1. The Inter-War Years

Robert E. Harkavy, in his book entitled, The Arms Trade and International Systems, published in 1975, compiled an extensive sample of licensing agreements covering the interwar period of the 1920's and 1930's, along with the percentage of transfers by major interwar suppliers through licensing.[2] One point that emerged was that licensing accounted for a significant proportion of total transfers during this period, averaging nearly 20% for categories other than warships and submarines. Second, licensing was most frequently utilized in the aircraft categories, next most frequently in armor and, naturally enough, the least in naval categories. Those small and medium powers that resorted most extensively to construction under license of a large percentage of their own aircraft such as Belgium, Denmark, the Netherlands, Norway and Sweden were still capable of designing and constructing independently their own naval craft.

As one might expect from the normal product cycle, Harkavy found that licensing was most frequently used with those weapons requiring the least technological sophistication, i.e., trainer aircraft, armored car and patrol boats.

Among the more active interwar arms suppliers which resorted to licensing were Czechoslovakia, Germany, France, Italy, the Netherlands, the United Kingdom and the United States. Other major interwar arms producers such as the USSR, Japan, and Canada were not active licensors being usually on the receiving end of licensing agreements, while striving for greater self-sufficiency.

In aircraft, Britian, Czeckoslovakia, and Germany licensed relatively high proportion of their transfers, France, the Netherlands, and Sweden fall into a

middle range, while the United States and Italy were only marginally involved as licensors (with the exception of trainers for Italy).

For the U.S. this can be easily attributed to a sales concentration on those nations outside of Europe that were located in Latin America and the few remaining independent nations: Turkey, China, Thailand, which obviously had less of a licensed production capability at that time.

Britain, particularly its Hawker Aircraft Company, licensed a fairly high percentage of its aircraft transfers, which were principally to the smaller European nations and Commonwealth members. Italy specialized in licensing trainer aircraft, primarily to Eastern Europe. France's aircraft licensing agreements were for the most part with its Eastern European allies but also its smaller neighbors, i.e., Belgium, Switzerland, Portugal and Spain. Germany was a significant licensor in the late 30's with its licensee's scattered across Eastern and Western Europe, but including Argentina and Turkey as well.

During this same period fewer nations were active licensors of armored cars and tanks; Czechoslovakia, France, Sweden, the U.K., and the U.S.

2. The Early Post War Period

In the early post war period, the United Kingdom was the only major European nation that had come through WW II with its defense industries in tact, and as such maintaining an independent capability. The Belgian, Dutch, and French industries began to rebuild through licensed production in the late 1940's, being joined by Italy in the early 50's, and the FRG in the late 50's. Almost all of

these systems were, naturally enough, of U.S. or British origin. However by the late 1950's the German industry was also building several French and Italian systems as well.

It was during this period of rebuilding in the 1950's that these Continental European members of NATO gained considerable experience in producing sophisticated foreign systems under license; mostly of Anglo-Saxon origin. This is the major distinguishing characteristic then of this Mode of collaboration. Not only is it the oldest, but is one in which the Europeans have had considerable experience, as licensees, in contrast to U.S. firms.

While all this was occuring most European equipment requirements of the late 40's and early 50's were being filled with U.S., Canadian, and British war surplus. This was followed by the extensive Cold War related grant of newer equipment in the 1953-55 period, and in the case of France, with its particularly heavy operational requirements in Indo-China and North Africa (and therefore greater dependence on U.S. equipment) up to 1962.

The funding starved French aerospace firms were nevertheless able to support a wide range of aircraft development projects, at this time, but only through a strong reliance on British avionics and engines. The less rationalized British airframe industry and its government were meanwhile actively involved in a dissipation of national resources.

The beginning of a rebuilding of the continental aerospace industry in the late 40's was reinforced with the setting up in 1948 of NATO's precursor, the Western Union Defense Organization. It was through the Western Union

the individual governments agreed to provide a stimulus for setting the continental European combat aircraft industry in motion again. Under a collateral Benelux production effort, Belgium undertook the manufacture under license of Derwent jet engines, for installation in Meteor aircraft, built in the Netherlands under license. Furthermore, France undertook to build under license the British Vampire aircraft, to develop a fighter of her own design, and manufacture Nene jet engines under license. Appropriate licensing arrangements were negotiated with British firms for all of these (except, of course, the French fighter development program). In the U.K., production of Meteors, Vampires, Canberras and jet engines was stepped up.

The number of bilateral licensed production agreements mushroomed over the following decade to include both Italy and the FRG as well, with the U.S. entering the picture for the first time as a major licensor. To name but a few of these:

- Sikorsky helicopters were built in France (S-68), and the U.K (the S-51, S-55, S-61);
- Bell helicopters were built in Italy and the FRG;
- Britain's Gloster Meteor was built in the Netherlands and Belgium;
- The F-84 and F-86 fighters, plus the M-47 and M-48 tanks were built in Italy;
- The British Venom fighter was built in France and Switzerland;
- The British Vampire fighter was built in Italy and France;
- The British Hawker Hunter was built in the Netherlands, Belgium and Switzerland;
- The Fiat G-91 fighters were built in the FRG;

- French Magister trainers, and Noratlas transports were built under license in the FRG.

Several of these programs are mentioned briefly elsewhere in this paper in another context, but here we'll look primarily at several more recent projects involving U.S. systems that originated during the 60's, so as to get an idea of how they're organized and managed. The projects covered in detail are: (1) the Italian production of the USA/FMC M-113 Armored Personnel Carrier which is an example of licensed production within the framework of an intergovernmental MOU, and (2) the Italian production of the USA/Boeing-Vertol CH-47 which is an example of standard commercial licensing (i.e. industry-to-industry, without governmental participation). Three other projects looked at in less detail are the license production of the French Noratlas in the FRG, of the Sikorsky CH-53 helicopter in the FRG, and the production of the Northrop F-5 fighter in Canada, the Netherlands, and Spain.

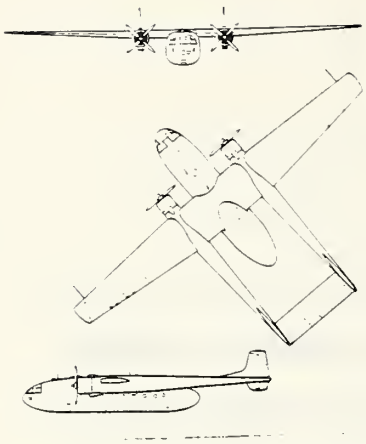
B. NORATLAS

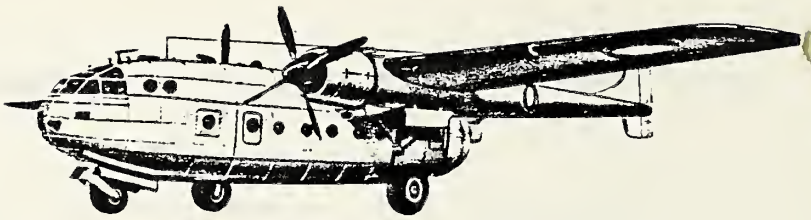
The Noratlas (and its production under license in the FRG) is the only case involving a non-U.S. system we'll look at in the small sampling covered by this chapter. The Noratlas is particularly interesting in that it encapsulates a number of developments of significance to the later evolution of industrial calloboration.

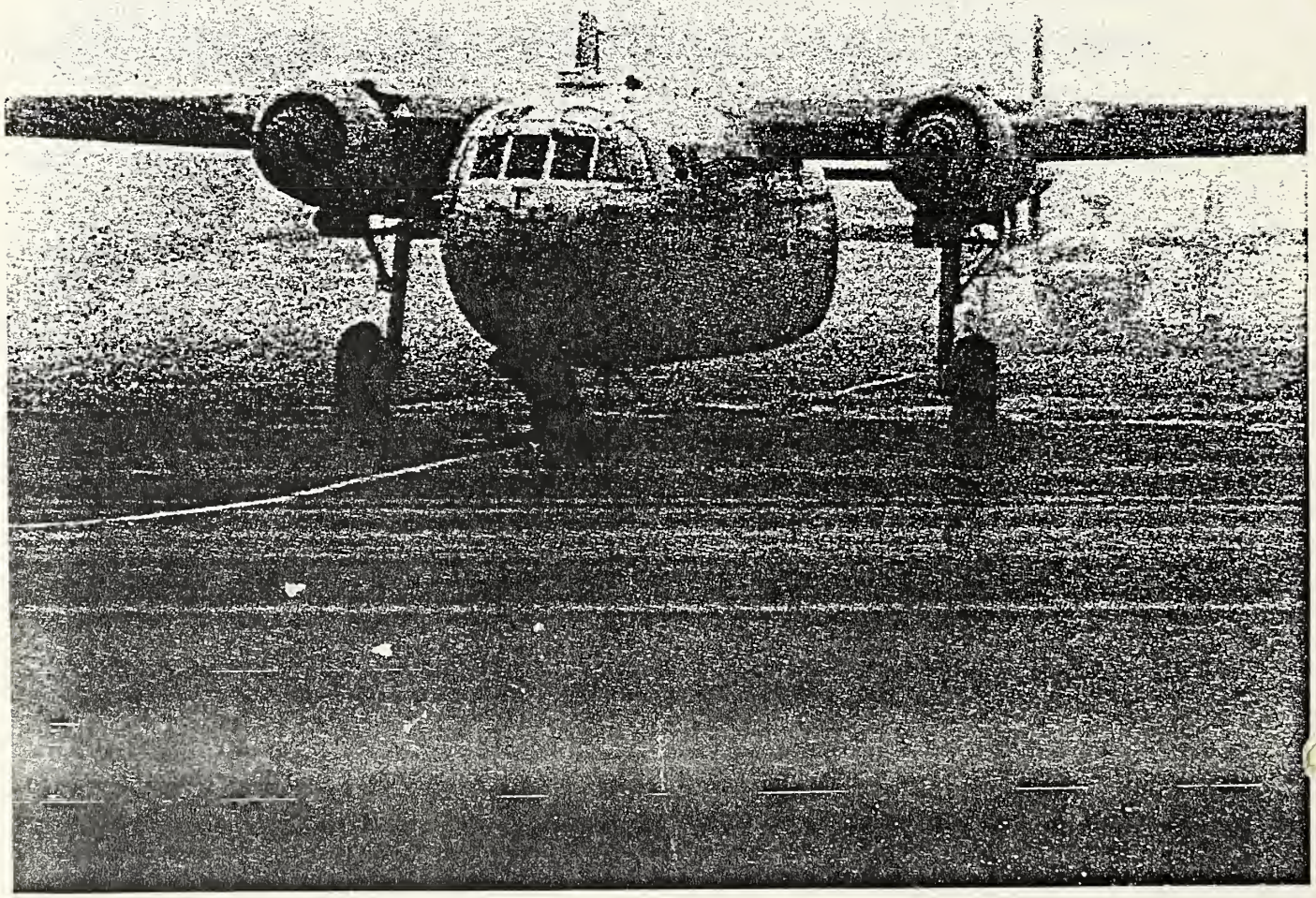
In the mid-1950's the FRG went into a crash rearmament program that involved major aircraft procurements directly from the U.S., Canada and Italy.[1] France was not a major supplier of aircraft to the FRG, but instead made possible through license work the first orders to the revived German aircraft industry. Of the four aircraft for which the FMOD first placed orders with German industry—the Noratlas transport, Fouga Magister jet trainer, Piaggio P-149 light aircraft, and the Dornier DO-27 light reconnaissance aircraft—the French were licensor's of the first two, Italy the licensor for the third, and only the forth was of indigenous design.[2]

The 188 Fouga Magister were produced by a manufacturing organization called Flug-Zeug-Union Sud consisting of Messerschmitt and Heinkel under license from France's Potez. The 194 Italian Piaggio P-149 light aircraft were manufactured under license by Focke-Wolfe. The DO-27 light reconnaissance aircraft, 428 of which were built, was developed by a German Company, Dornier, having been designed in Spain by Professor Dornier before 1955.

The Noratlas 2501 transport was licensed from Nord Aviation (later to be the French partner for the Transall project, and eventually becoming part of





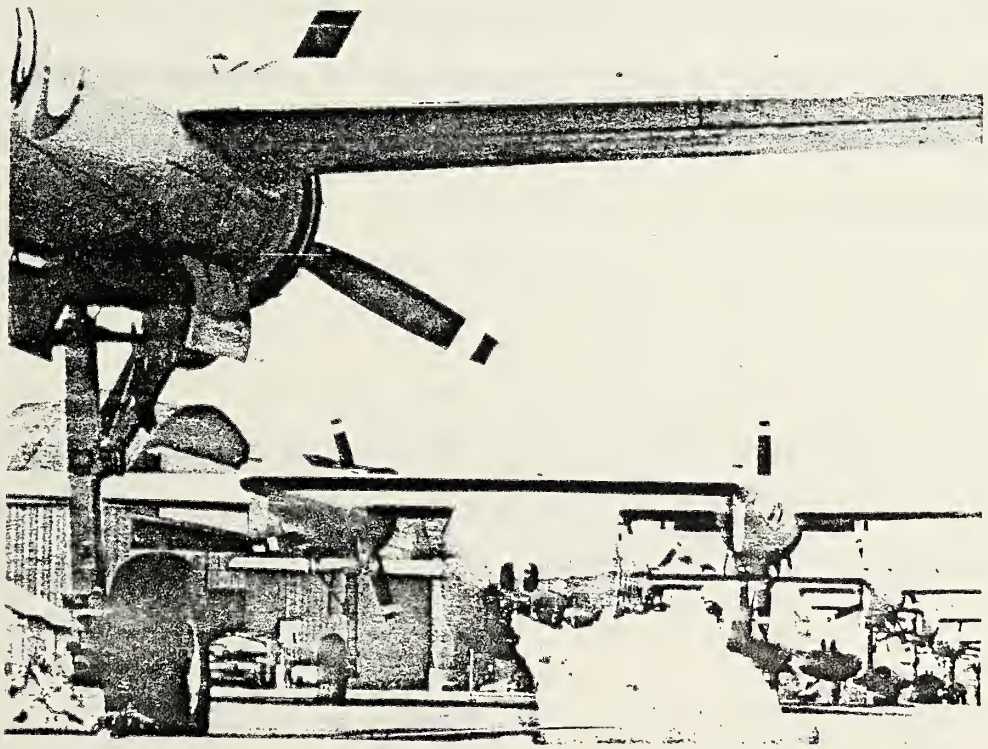


Source: Air Actualites



Le Noratlas, plus de 30 ans de bons et loyaux services (photo SIRPA Air).

Although the N.2501 has been in inventory for nearly twenty five years, this transport aeroplane still remains the workhorse of COTAM. Photo: Col. Adias



SNIAS) to a manufacturing organization, Flugzeugbau Nord. Flugzeugbau Nord was one of the 'paper' companies that preceded the series of mergers in the German aerospace industry during the mid and late-1960's.[3] When these paper companies or consortia were later extrapolated to the European level, they were the beginning of a more long lasting phenomenon that has, and will continue to defy what might at first glance seem to be the next logical step, transnational mergers.[4] Each of these collaborative companies operated for the duration of the manufacturing program only—the revived firms being much attached to their separate traditional identities.[5]

The first flight of the Noratlas took place in 1950. Nord Aviation built some 250 Noratlas (including 25 bought directly by the FRG), while the Flugzeugbau

Nord consortium of HFB, Weserflug, and Siebelwerke built another 161 with management and technical assistance from Nord. As is the norm for such licensed parallel production efforts, the French and German governments contracted directly with the individual national firms for the work done.[6] The later C-160 Transall transport project was an outgrowth of this project, which the same grouping of French and German firms jointly designed, developed, and manufactured.

C. ITALIAN PRODUCTION OF THE M-113[1]

Following shortly upon the series of European joint license production programs launched between 1958 and 1962 Hawk, F-104G, Bullpup, Sidewinder and Mark 44 torpedo (all except the Mark 44 being treated in the next chapter), the U.S. Secretary of Defense and the Italian Minister of Defense met in November 1962, to finalize a logistical agreement whereby Italy would buy some $128 million worth of military hardware from the U.S. Included in this purchase were 1,000 M113 armoured personnel carriers (APC's). During these discussions the Minister of Defense indicated that Italy had a total requirement of 4,000 M113's and was extremely interested in producing the remaining 3,000 in Italy. More specifically the Italians also agreed to finance the entire project - prior similar projects had involved MAP funding - to include procurement of components and purchase of technical assistance and documentation from the U.S. Government and industry.[2]

The Secretary of Defense agreed to the co-production program on December 12, 1962, directing the Secretary of the Army to develop an MOU and designate a project manager with the authority to ensure a smooth transition. The acting Assistant Secretary of the Army designated the U.S. Army Materiel Command (AMC) as Department of the Army Agent to carry out the Secretary of Defense directive.

Col. Francis E. Abrino was appointed as the U.S Project Manager. Abrino decided to fully utilize the existing organization within AMC Headquarters and the field, thus enabling him to organize a small office of five people.[3]

Concurrent with the Project Manager's designation, the Secretary of Defense requested full cooperation of the FMC, producer of the M113's in the U.S. FMC was requested to deal directly with the Italian co- producers - OTO Melara, Fiat, Lancia.[4]

1. Establishing the General Framework for Co-production

a. The MOU

The Project Manager visited Italy in January 1963 to discuss a draft MOU with the Italian government. The Memorandum of Understanding was signed on February 12, 1963 by the Italian Minister of Defense and the American Deputy Secretary of Defense. Throughout the duration of the project, this MOU proved to be comprehensive and practical in assuring the project's smooth implementation. The following is an outline of the five page MOU, which will serve to give the reader an idea of its scope and content.[5]

The introduction covered:

(1) the preference for a direct industry to industry approach to accomplish this production;

(2) pertinent previous agreements;

(3) technical arrangements, and;

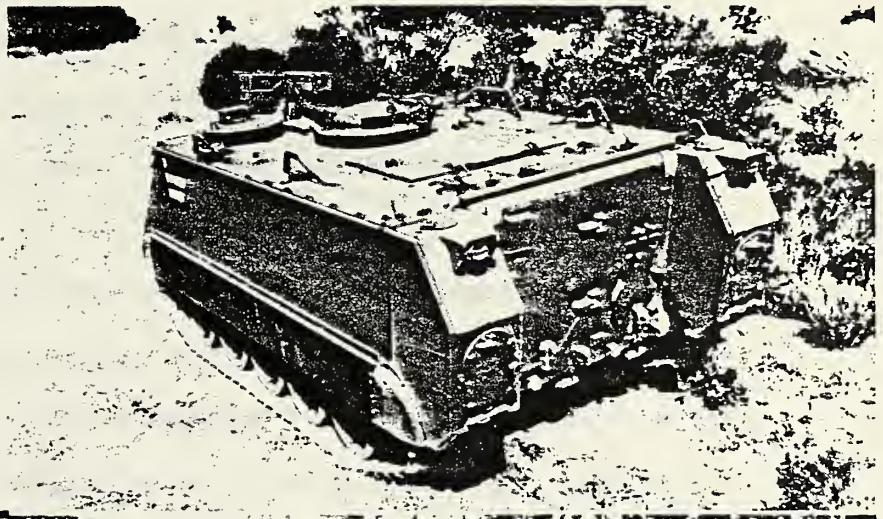
(4) security measures.

Next it elaborated upon the responsibilities of the U.S. government in the following areas:

M113 FAMILY
ARMORED CARRIERS FOR THE 1980's

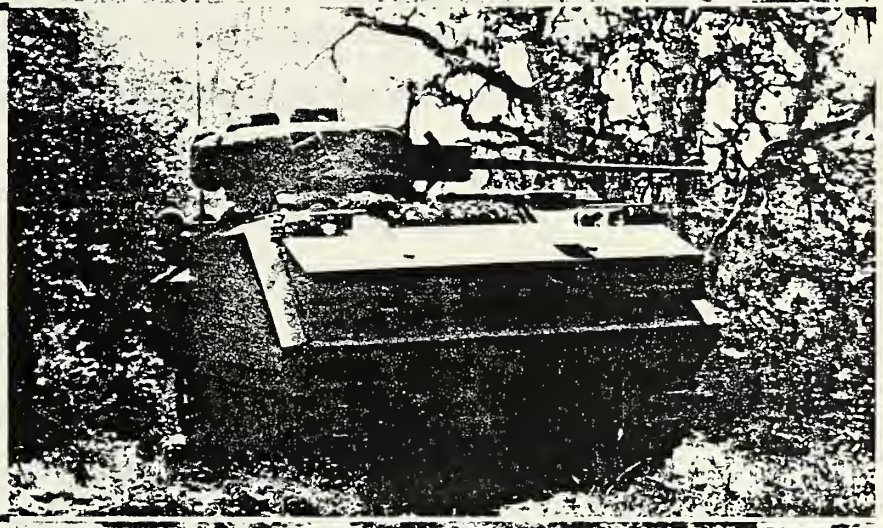
The M113A2

- Improved
  Reliable
  Performer



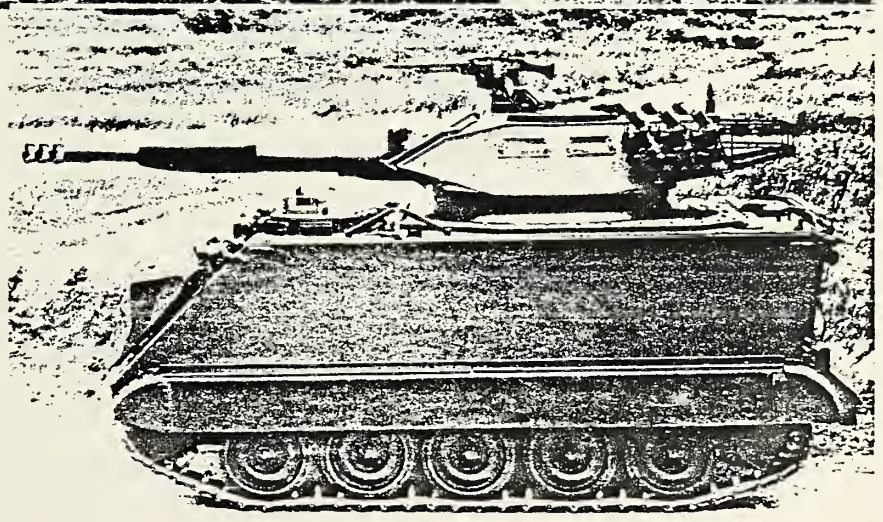
The AIFV

- Armored
  Infantry
  Fighting Vehicle



The FSV

- 90 mm Fire
  Support Vehicle



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FMC Ordnance Division

(1) documentation to be furnished;

(2) authorized use of documentation;

(3) special tooling and industrial facilities;

(4) designation of a project manager, and;

(5) miscellaneous technical, administrative and engineering services.

The responsibilities of the Italian government concerned:

(1) an agreement to maintain standardization;[6]

(2) requirement for U.S. approval of deviations;

(3) agreement to permit surveillance by U.S. representatives;

(4) inventions, data and information;[7]

(5) the required amount of expenditures in the U.S.;

(6) identification, and;

(7) the designation of an Italian representative to assist the U.S. Project Manager.

Responsibilities of both governments covered:

(1) Protection of privately owned proprietary rights;

(2) coordinated production schedules;

(3) progress reports and;

(4) the resolution of differences.

And finally, there were the general considerations, which covered termination and amendment of the MOU.[8]

b. Development of Technical Procedures

Shortly after the MOU was signed the project manager met with the President and other officials of FMC to define the interrelationships and roles of both FMC and the U.S. Government with the Italian Government and industry.[9]

In April 1963, discussions were held with the Italian Government and industry to develop the standard operating procedures which would implement the MOU as well as provide a means of managing the program. The Project Manager was able to take advantage of some of the technical procedures previously developed in connection with the NATO-HAWK Cooperative Production Program. Using these procedures and technical assistance from U.S. Army Tank-Automotive Command (TACOM) personnel, eight technical procedures were agreed upon as follows:

(1) Reimbursement;
(2) U.S. technical documentation;
(3) Approval of Italian documentation;
(4) U.S. technical assistance;
(5) Deviations;
(6) Interchangeability definitions;
(7) Use of Italian engineering requests, and;
(8) Use of differing materials (previously established NATO specifications).[10]

These technical procedures were signed by the Project Manager and representatives of the Italian Government, FMC Corporation, OTO Melara, FIAT and Lancia, and continued in effect with minor changes up to project termination.

Further, they were used as the model procedures for subsequent coproduction programs.[11]

At the same time the following 3-phased production schedule was established:

(1) Phase I, to begin January 1964, 200 APC's were to be assembled from U.S. production parts.

(2) Phase II, to begin July 1964, 200 APC's were to be assembled with some Italian manufactured parts.

(3) Phase III, to begin January 1965, 2,600 APC's were to be assembled with an optimal percentage of Italian parts.[12]

c. Transfer of the M-113 Technical Data Package (TDP)

The Italian Government requested a complete TDP from the U.S. in early January 1963. The U.S. Project Manager expedited its preparation and furnished it (through the Military Assistance Advisory Group, Italy) to the Italian Government in late January, 1963. To satisfy a special Italian request, reproducible hard copies were furnished in lieu of microfilm.[13] The Italian Government, in turn, furnished the TDP to the prime Italian co-producer, OTO Melara, who translated it and converted the dimensions to the metric system in three months. Concurrent with furnishing this TDP, procedures were established to preclude any technical information from being transmitted or transferred outside of Italy without U.S. approval.[14]

d. Exchange of Personnel

The Italian Government requested that a U.S. Government representative be stationed in the OTO Melara plant, on a reimbursable basis. The presence of an Italian-speaking U.S. Government technical representative with an engineering background proved to be a valuable element in the smooth implementation of the program.[15]

FMC also stationed a representative in Italy in support of their contract arrangements with the co-producers.

In September 1963, the Italian government and industry sent nine men to two FMC plants, the Aberdeen Proving Ground, and TACOM for an eight weeks' training program.[16]

e. BOP Stipulations

In the MOU, the Italian government agreed that an average of 50% of the cost of components, sub-assemblies, finished and other materials would be spent in the U.S., through the purchase of these, as well as machinery and technical assistance and support from U.S. sources. This percentage was translated into fixed figure for administrative ease, being estimated at $30 million. As of mid-1970 the Italians had expended $36 million in the U.S.

2. The Industry-to-Industry Relationship

a. The FMC-OTO Melara License Agreement

The MOU had stipulated that maximum industry to industry participation be encouraged in implementation of the program. The Secretary of Defense as well had encouraged FMC to deal directly with the Italian co-producers. During March through May 1963, FMC representatives met with OTO Melara, Lancia and FIAT, and worked out a license agreement which was signed on 1 June, 1963, and approved by the two governments on 27 June, 1963. Essentially this agreement required FMC to provide production know-how to the Italian co-producers and to act as purchasing agent for them for components being furnished by U.S. suppliers. FMC was to be paid a know-how fee and, in addition, a royalty of up to $1,240 for each vehicle produced in Italy. This technical agreement was established for a period of ten years and is reported to have worked satisfactorily.[17]

FMC was obliged to:

1. Establish and maintain a separate department to be formed within its Ordinance Division to handle all matters concerning the Agreement, it being understood that the costs of this department would be kept to the lowest practical amount.
2. Supply manufacturing drawings to US standards, bills of materials, manufacturing sequence and hours of labor per part, etc.
3. Supply supplemental drawings and other improvements to keep all original information up to date.

4. Supply technical advice regarding production techniques including all proprietary knowledge on parts manufactured by FMC and its parts suppliers for which FMC has manufacturing rights.
5. Supply technical advice and/or designs regarding the making and use of tooling.
6. Supply advice and information regarding sources of supply of items purchased by FMC for Oto Melara including delivery terms and prices.
7. Supply gauge design data and gauges as required (in addition to those that might be supplied by the US).
8. Prescribe inspection procedures.
9. Provide English texts for training and operational manuals.
10. Train personnel of FIAT, Lancia and OTO Melara and any other subcontractor or co-producer in the US or Italy on manufacturing operations and procedures.
11. Provide surveillance of Italian on-site inspection and approval of any deviations.
12. Act as an agent to procure and control shipments of items manufactured in the US.
13. Perform any requested services and inspections of items of outside procurement.[18]

Technical services assistance to be rendered by FMC included: assistance rendered by managerial, engineering, production and staff personnel of the company and its supporting activities, including activities such as question-answering, providing advice and suggestions, explaining designs, investigating

specific problems, obtaining information, and performing other duties to effectuate the purpose of the agreement.[19]

As the Italian government had previously agreed in the MOU to maintain standardization and the flow-back of technical data on any improvements, OTO Melara obligated itself in the license agreement to: build M-113's and related vehicles in accordance with United States standards specified by FMC with particular attention to maintaining interchangeability of components and parts between vehicles produced in the United States and those produced in Italy (with certain agreed exceptions)[20] - notify the U.S. Government through the Italian Ministry of Defense and FMC of any improvements in design and production methods and techniques suggested by OTO Melara. Such improvements are subject to the approval of the United States Department of Defense or FMC, prior to incorporation into the vehicles.[21]

b. Construction of Co-Production Facilities in Italy

In order to take advantage of FMC's M113 production experience, Italian industry had a production line constructed at OTO Melara, in La Spezia, Italy, that was a carbon copy of FMC's plant at South Charleston, West Virginia. In so doing the Italians purchased special routers, transfer mechanics and other industrial plant equipment which had been developed solely for U.S. production of the M113.[22] The decision to take advantage of FMC's plant layout experience permitted Italy to begin assembling M113 APC's in a relatively short period of time.[23]

c. First Vehicle Delivery and Testing

The first Italian assembled M113 was delivered in December, 1963. The Italians had translated the technical data package, established a production line, purchased testing equipment, and developed sources of supply, within 10 months of the signing of the MOU. This accomplishment was attributed to the determined attitude of the Italians, the excellent relations developed between the Italian government and the U.S. Project Manager, and between the Italian co-producers and the U.S. suppliers.[24]

In their testing of vehicles, the Italian Army had agreed to follow essentially the same testing procedures used in the U.S., and thereby benefit from previous U.S. experience in testing production models of the M113.[25] In 1965, after a production vehicle had been shipped to the Aberdeen Proving Ground and given a 4,000 mile cross-country type test, the U.S. Army Test and Evaluation Command stated that the Italian vehicle was equal to or better than American produced vehicles.[26]

d. FMC Agreement to Furnish On-Vehicle-Equipment (OVE)

In developing their "make or buy" plan, the Italian Government decided to buy some items in the U.S. which were under the jurisdiction of Army supply organizations (e.g. DSA or arsenal supplied items). Recognizing that it would be difficult to support production in Italy through the normal Army or DSA supply channels, the Project Manager obtained FMC's agreement to procure such items from U.S. Government supply sources and supply them to the Italian

co-producers. The Project Manager obtained approval to provide this authority to FMC from the Assistant Secretary of the Army in May, 1964.[27] This decision proved to be highly successful since timely shipments of such components helped avoid production stoppages in Italy.[28]

e. Purchase of Major Components in the U.S.

The Italian firms purchased the two main mechanical components of the M113 family in the U.S. - the Chrysler M75 Engine and the GMC Allison TX200-2B Transmission. The Italians opted for purchasing the engines directly from Chrysler, but decided to utilize FMC as its purchasing agent for the transmission and several other U.S. produced items. For a small administrative fee charged by FMC, they thus had a U.S. based procurement system at their disposal that could consolidate their orders with FMC procurements and expedite deliveries.[29]

3. Role of the U.S. Government

The U.S. Government made every attempt to insure that the program would go smoothly, especially in consideration of the emphasis placed on it by the Italian government, and the projects resultant high visibility.

a. Coordination with FMC

During January and February, 1963, there was an exchange of letters between Deputy Secretary of Defense Gilpatric and the President of FMC, Mr. Hait,

which established the role of FMC. With this correspondence as a basis, the Project Manager met with representatives of FMC in March 1963 to:

(1) Apprise the parties of program status;

(2) Establish a coordinated effort and solicit FMC's assistance in developing procedures for the program;

(3) Assist FMC in the preparation of the industry to industry technical agreement; and

(4) Clarify FMC and the U.S. Government areas of responsibility.[30]

FMC took the following positions:

(1) FMC's efforts to support the project would be as if all M113 AFC's would carry their trademark.

(2) FMC's actions would be mainly confined to:

(a) Providing production know-how in materials, and

(b) Acting as agent for Italian industry in procurement of certain items in the U.S.

(3) FMC would perform surveillance in Italy of receipt of both FMC and U.S. Government furnished items.

(4) FMC would accept joint responsibility with the Italian companies for a quality product.

Mr. Hait then advised Secretary Gilpatric that a clear and acceptable understanding had been reached with the Project Manager as to FMC's basic responsibilities.[31]

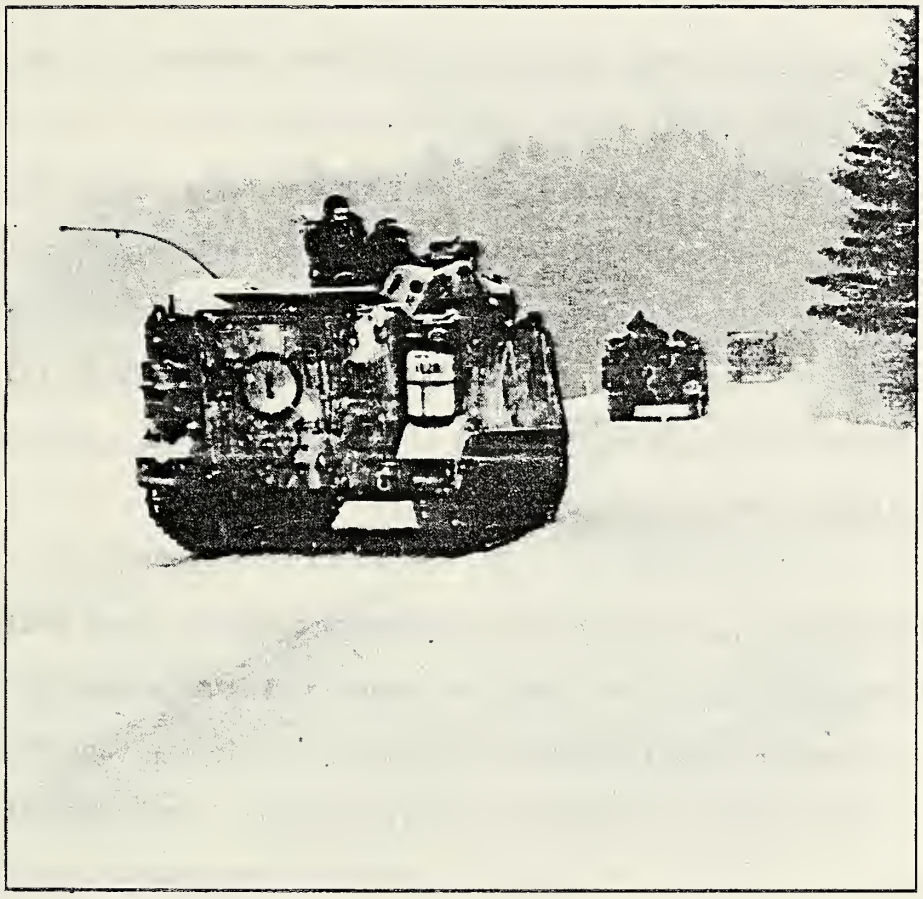
b. U.S. Project Manager Responsibilities

After discussions with the Italian Government, Italian industry and FMC, it became evident that the principal functions of the Project Manager were to:

(1) Monitor the expenditures by the Italian Government and industry in the U.S. in accordance with the clause included in the MOU;
(2) Provide materiel, services and documentation to the Italian Government and industry on a reimbursable basis;
(3) Perform surveillance of Italian production schedules to insure that there would be no interference with U.S. Army commitments, and supply of critical components from U.S. suppliers;
(4) Safeguard industry proprietary rights, and;
(5) Exercise configuration management of the Italian co-production through the right of engineering change and deviation approval.[32]

c. M-113 Co-production Office at TACOM

The Project Manager and the Commanding General, TACOM approved a Joint Responsibility Agreement delineating TACOM's responsibilities for the M113 Co-Production Program. This involved the establishment of six personnel spaces at TACOM in October 1963 for the planning, advising, monitoring, and coordinating of all activities there, related to the program (i.e., planning, engineering, quality assurance, testing, supply, and fiscal matters).



▲ *M113s of Wisconsin National Guard moving into position in Bavaria*

REFORGER '86 has completed the cycle of winter exercises for the US Army —

d. Technical Assistance FMS Case

The Italian Government and industry agreed to reimburse the U.S. Government for any documentation and technical assistance provided. In June, 1963 the Italian Government accepted an offer by the U.S. Government in the form of a Foreign Military Sales (FMS) case to furnish $210,000 worth of technical assistance during FY 1964. This sales case established U.S. technical support in the areas of quality assurance, engineering requests, performance testing and evaluation, review of deviations, provision of engineering change orders, source inspection[33] and qualified product testing.[34]

e. Flexibility Displayed on the Part of U.S. Government in Obtaining Timely Delivery of Items Produced in the U.S.

In 1968 the Italian Army decided to have 50 more M577's - one of the M113 vehicle family co-produced in Italy - produced. The generator utilized in this vehicle had previously been purchased in the U.S. through FMS channels. In order to circumvent the lengthy process involved in obtaining this additional order of generators through the ordinary procurement procedures, the Army approved a special expedited procurement in recognition of the U.S. commitment to the program.

In addition when the Italian firm, Oto Melara, placed a purchase order for $26,760 with the Stewart-Warner Corporation for some five different types of instruments, they were informed by the U.S. firm that the current workload

would not permit them to meet the requested delivery schedule. However, through the assistance obtained by the U.S. Project Manager, and in consideration of the need to avoid the shutdown of the production line for a defense program of importance to the U.S. Government, the order was able to receive a Defense Order (DO) Rating.[35] As a result the instruments were fabricated and delivered to OTO Melara within a satisfactory period of time.[36]

f. Inspection

Key Inspection visits were instrumental in enabling the Italians to co-produce high quality vehicles at economical costs. Beginning in 1964, annual Key Inspection services were requested by the Italians. In the initial visit to the coproducers, the TACOM quality assurance experts thoroughly explained the quality control system employed by the U.S. Army and laid the ground work for its use in this program. Annually thereafter the team visited the Italian Army installations and thoroughly reviewed their quality control practices and contractors' plants over a four to six week period.[37]

g. Source Inspection

Source inspection was furnished to the co-producers at their request and expense, for those parts and materials purchased in the U.S. directly from commercial sources.[38] The inspection, or in many cases the verification of the supplier's inspection, was handled by local DCAS personnel of the areas where supplier's plants were located.[39]

h. SSA

For those M113 repair parts produced only by U.S. manufacturers, the Italian Army utilizes the U.S. supply system, thus reducing the cost of these parts through consolidation of their requirements with those of the U.S. (as well as other nations using supply support arrangements (SSA) for the M113). In January 1966 Italy signed its initial SSA with the U.S., the arrangement being renegotiated each year with the U.S. Army Materiel Command, Europe.[40]

4. Additional M-113 Related Contracts with Italian Industry

a. Offshore Procurement of M113 Vehicles Under MAP

As part of the 1964 Hawk-Barter Memorandum of Accord with Italy,[41] the U.S. purchased M113 APC's from OTO Melera for delivery to a third country under the Military Assistance Program (MAP). The deliveries were scheduled between 1968 and 1970, for two lots of 360 and 121 vehicles.[42]

b. Offshore Procurement from OTO Melara for the U.S. Army Europe

Southeast Asia requirements in 1965 created a supply problem for depot overhaul and troop support of the M113 in Europe. Expediency suggested that an alternative source of supply be developed in Italy. The TACOM Liason Officer in Italy obtained price and availability data from OTO Melera for the established requirements, and the U.S. Project Manager obtained authorization for

the offshore procurement of spare parts. As a result of these coordinated efforts, 113 line items valued at approximately $1.6 million were purchased from OTO Melara in 1966. Since then, offshore procurement has continued on a routine basis as required.[43]

c. Extended Production

In December 1968, the Italian Ministry of Defense informed the U.S. Project Manager of Italy's intention to extend production beyond the 3,000 vehicles originally scheduled. In May 1971 the Italian Army awarded a new contract for production of 600 additional vehicles with a modified configuration, the M113A1. The last vehicle delivery was scheduled for late 1973.[44]

5. Several Issues Relevant to License-Production Generally

a. National Versus International Standardization

During the initial stages of coproduction program the U.S. was beginning to adopt the AN/VRC-12 series radios for use in its M113 APC's and M60A1 tanks. Although having been furnished the technical data by the Project Manager, in an effort to convince them to use the VRC-12, the Italian government decided against it. Since all of their other vehicles had the GRC 3 through 8 series radios, the Italian government decided to maintain national standardization.[45] The Italian government requested and eventually received a technical data package for the GRC 3-8 radics.[46]

After some initial problems with the Prestolite starter used in the 1000 U.S. manufactured M113's, the Italian government decided against purchasing the manufacturing rights for this starter. Instead, it was decided that an Italian made Marelli starter would be used, one that was in common commercial use and which would assure the Italian Army of in-country support. Although the Marelli and Prestolite starters were interchangeable as complete units, their components were not. Even though the U.S. Project Manager informed the Italians that use of the Marelli starter was not in conformity with co-production requirements for interchangeability, the Italian Program Manager felt it was his perogative, and went with it. This was the only other significant deviation from the U.S. configuration in the entire program.[47]

b. Beneficial Exchange of Data

The licensed production of track shoes provides an indication of the benefits that can accrue from the exchange of data in co-production programs. After learning that the T-130 track manufactured by FIAT had a 75% longer wear life to the track manufactured in the U.S., U.S. supply contracts were amended to require more stringent quality assurance provisions, and subsequent contracts called for the use of higher quality steel.[48]

c. Infringement of Proprietary Rights

The protection of U.S. propietary rights related to the M113 was covered in the MOU. There was only one reported case of infringement by Italian manufacturers on U.S. held proprietary rights. Along with the technical data

package was the list of the proprietary items (and their owners), which the Italian manufacturers could either purchase or negotiate licensing agreements. In early 1965 Piqua Company advised that there was evidence of violation of their proprietary rights, after which it was determined that the Italian firm concerned had inadvertently utilized some 37 drawings which turned out to be proprietary to Piqua. Following discussions and correspondence between the Project Manager and the Italian representative, and agreement was reached whereby the Italians would purchase 4,000 pumps from Piqua and cease to manufacture any more of them.[49]

6. Lessons Learned

The Army document provided the following lessons learned:

(1) It is necessary that the U.S. Government serve in a monitoring role[50] to assure successful co-production programs in the following areas:

   (a) Provision of documentation.

   (b) Maintenance of configuration integrity, i.e., control of deviations and waivers.

   (c) Gold flow.[51]

   (d) Technical, administrative and engineering assistance to foreign government and foreign industries.

   (e) Assistance in expediting the supply of U.S. made components to foreign manufacturers.

   (f) Protection of proprietary rights.

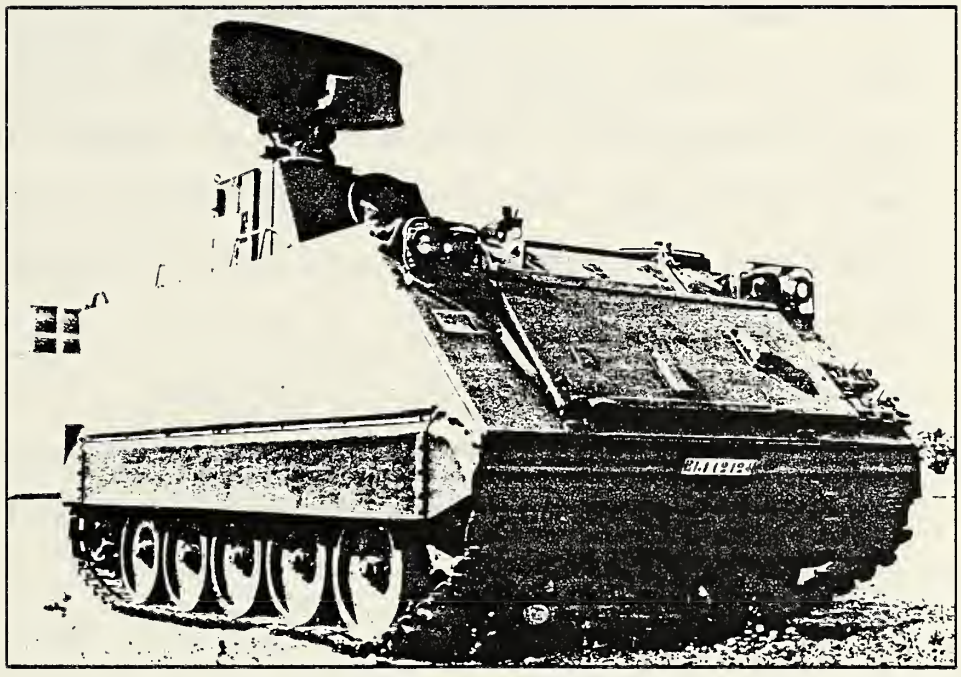
(g) Provision of U.S. Government owned components to foreign governments.[52]

(2) It is essential to the successful completion of a co-production project that there be maximum industry to industry participation. In the M113 Co-Production Project, FMC, Chrysler and Allison were encouraged to deal with Italian industries and, in fact, did support the Italian co-producers with a minimum involvement from the U.S. and Italian Governments.[53]

(3) To assure that the foreign co-producers receive high quality component parts from U.S. suppliers, it is essential that the U.S. Government provide source inspection.[54]

(4) To assist the foreign industries and governments in establishing efficient production facilities and in the start-up of production, a U.S. Liaison Officer stationed in country can be of inestimable value, particularly during the early stages of the project. A technically qualified, language proficient liaison officer can preclude misunderstandings, provide timely coordination, and resolve problems on the spot.[55]

(5) Foreign governments and co-producers should be encouraged to adopt U.S. quality assurance procedures including qualified products listings. This is to take advantage of the quality assurance procedures and plans that have been proven effective by the U.S. Government and producers.[56]



The SHORAR surveillance radar developed by Contraves Italiana as a successor to the LPD-20 is available as an autonomous system in two versions — a self-propelled variant, installed on an armoured vehicle such as the M113 APC (seen here), and the trailer-mounted *Pagoda* model — as well as being used on the ADATS missile system and the *Escorter* self-propelled twin-35mm AA gun.

(6) It is essential that an intensive training program be established early in the project to train both foreign government and industry inspectors and technicians in the U.S.[57]

(7) Insofar as practicable, and in consideration of continued good international relations, the U.S. (a) should not acquiesce to foreign government requests for more detailed FMS case billing information than is normally furnished a customer; (b) should avoid deviations from established billing procedures; (c) should establish and implement procedures which would allow for the identifying of costs related to the co-production effort when other effort is included in a U.S. Government to industry contract.[58]

(8) The designation of a foreign program manager and a U.S. representative or project manager at the beginning of a program is excellent management practice.[59]

(9) Through licensed co-production projects, the foreign policy objectives promoting exports and the advantages accruing to NATO RSI are achieved.[60]

Several other Lessons Learned offered by this project include the following.

- Foreign second sources can serve to eliminate supply bottlenecks during surges in demand that temporarily outstrip U.S. capacity.

- Though the maximizing of international standardization is an important goal, some deviation is inevitable in those cases where the advantages of national standardization or commercial availability are overwhelming.

- A licensor will often benefit through the flow-back of some technology or know-how from the licensee.

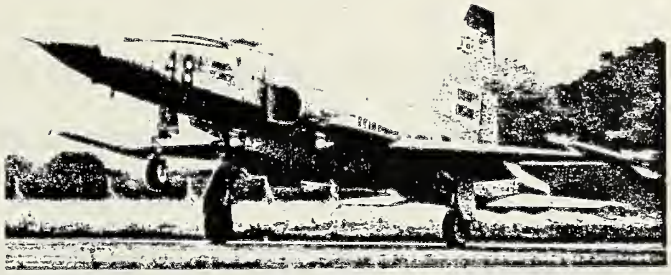
D. LICENSED PRODUCTION OF THE F-5 IN CANADA, THE NETHERLANDS AND SPAIN[61]

1. The System

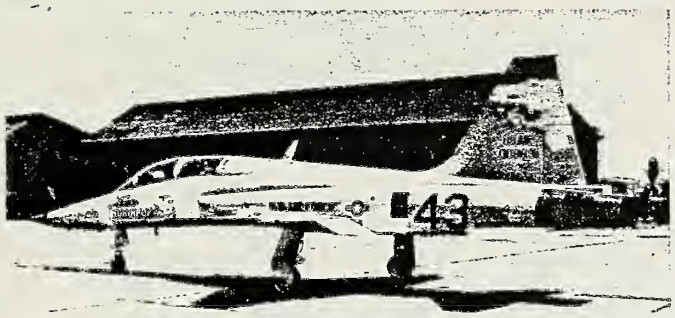
The Northrop F-5 is the first aircraft designed in the U.S. specifically for meeting the needs of the air forces of other countries. The F-5, in its various versions, serves as a light fighter, and advanced trainer and a reconnaissance aircraft.

Production of the first batch of 85 F-5's began in October 1962, with first delivery to Iran some 28 months later. The foundation for the program, however, had been laid nearly a decade earlier, when Northrop began a comprehensive study of user needs. The Northrop survey showed that there was a stong need for an airplane that could meet the operational readiness and maintenance requirements of the user countries. In light of the dearth of technical personnel capable of maintaining the aircraft, and the sharply rising costs of operating and maintaining fighter aircraft, the F-5 was designed to allow recipient countries to achieve maximum self-sufficiency.[62]

Simultaneously, Northrop had been pushing the concept that DOD should fund the development of an aircraft designed specifically to meet the needs of allied countries. This, plus the DOD's growing awareness of the cost of maintaining aircraft phased into allied air forces, led to the award of an $85 million R&D contract to Northrop in 1958 to manufacture three prototype aircraft, designated N-156F (the original Northrop design from which both the T-38 Talon and



Un F5 de l'Agressor Squadron (Sgc J.-P. Gauthier).



Au salon du Bourget le biplace F5 E (Coll. FP).

Construits au Canada sous licence Northrop les CF5 A et B sont les versions monoplace et biplace canadiennes des biréacteurs F5 "Freedom Fighter".



Au sein des Forces Armées canadiennes le CF 5 est désigné... CF 116. L'appareil, dans ses différentes versions A, B et "reco", équipe trois escadrons tactiques dont le 433rd Tactical Fighter Squadron basé à Bagotville (Québec).

Deux unités se déplacent assez fréquemment leurs avions étant ravitaillés alors en vol par des CC 117 (version du B 707-320 C transformée en ravitailleur en vol par adjonction de nacelles spéciales aux extrémités de la voilure).

Source: Air Actualites

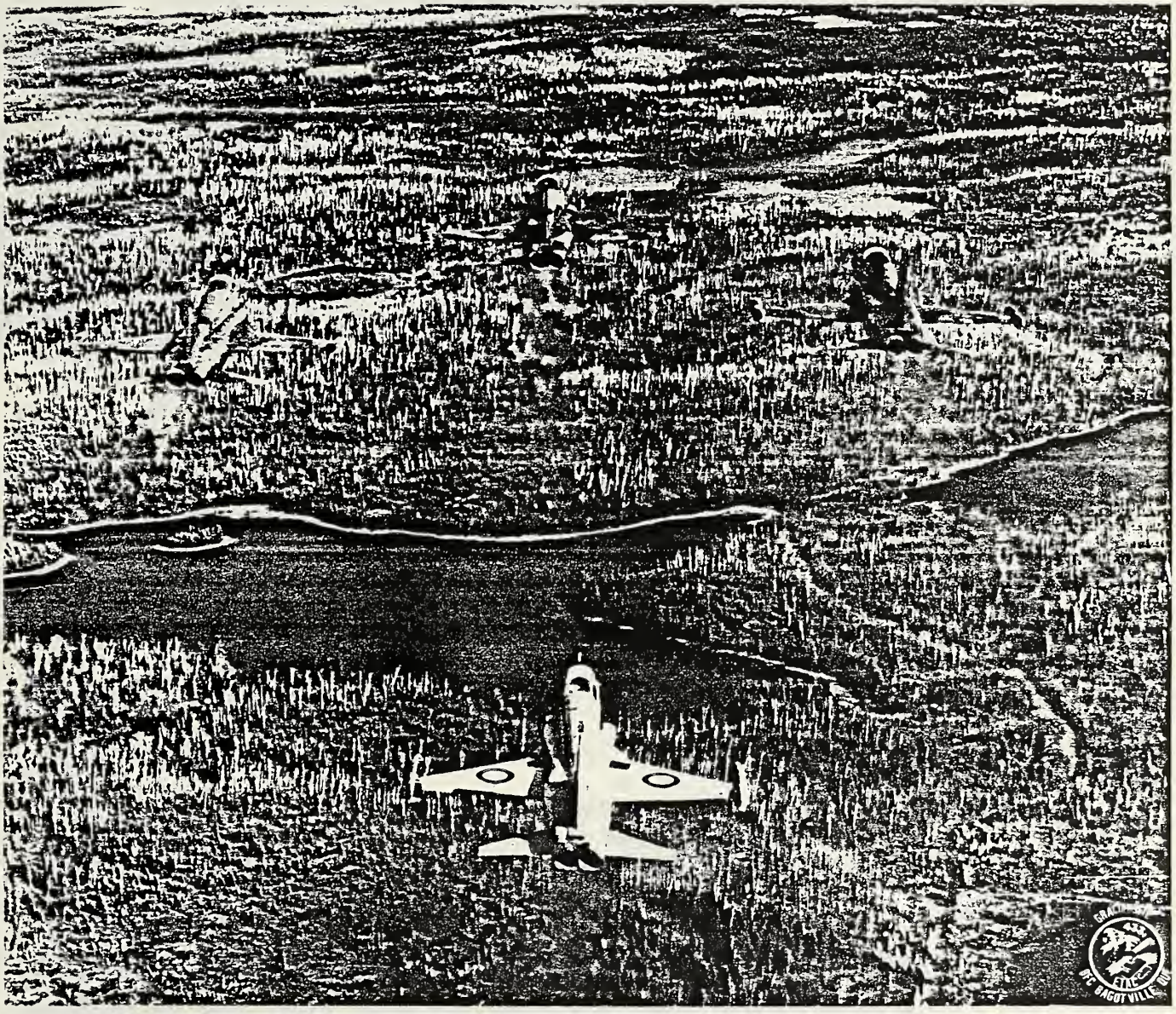
F-5 were developed). This is noteworthy in that it marked the first time that MAP money had been spent for R&D on a U.S. weapon system specifically intended for allied countries.[63] Earlier funding for the development systems tailored to allied requirements had always involved foreign industry under the Mutual Weapons Development Program.[64]

Within the constraints of meeting the air-to-air and air-to-ground performance tasks, Northrop emphasized maintenance simplicity and operation economy so as to maximize total force effectiveness. This included the following:

- Use of off-the-shelf components of proven reliability.
- Providing ready access to airframe components; 124 removable panels, representing about one-fourth of the fighter aircraft's fuselage, were designed to provide quick access to one-deep components.
- Designing the aircraft so that components could be built in widely separated locations for final assembly in one area.[65]

2. The CF-5 and NF-5

In 1965, Canadair Ltd., Montreal, a subsidiary of General Dynamics Corporation, became the first licensed producer of the F-5. The license agreement however, was actually between Northrop and the Canadian government. Canadair built 115 CF-5's for the Canadian government and 105 NF-5's for the Netherlands (the latter under a joint program with Fokker). Some 73 of the CF-5 aircraft produced for Canada were kept in storage due to lack of operating funds. Venezuela became interested in these and bought 20 CF-5's in 1972. Canada subsequently ordered 20 additional CF-5's to replace those ordered by



Formation de quatre CF5 survolant la province du Québec (photo 433e ETAC).

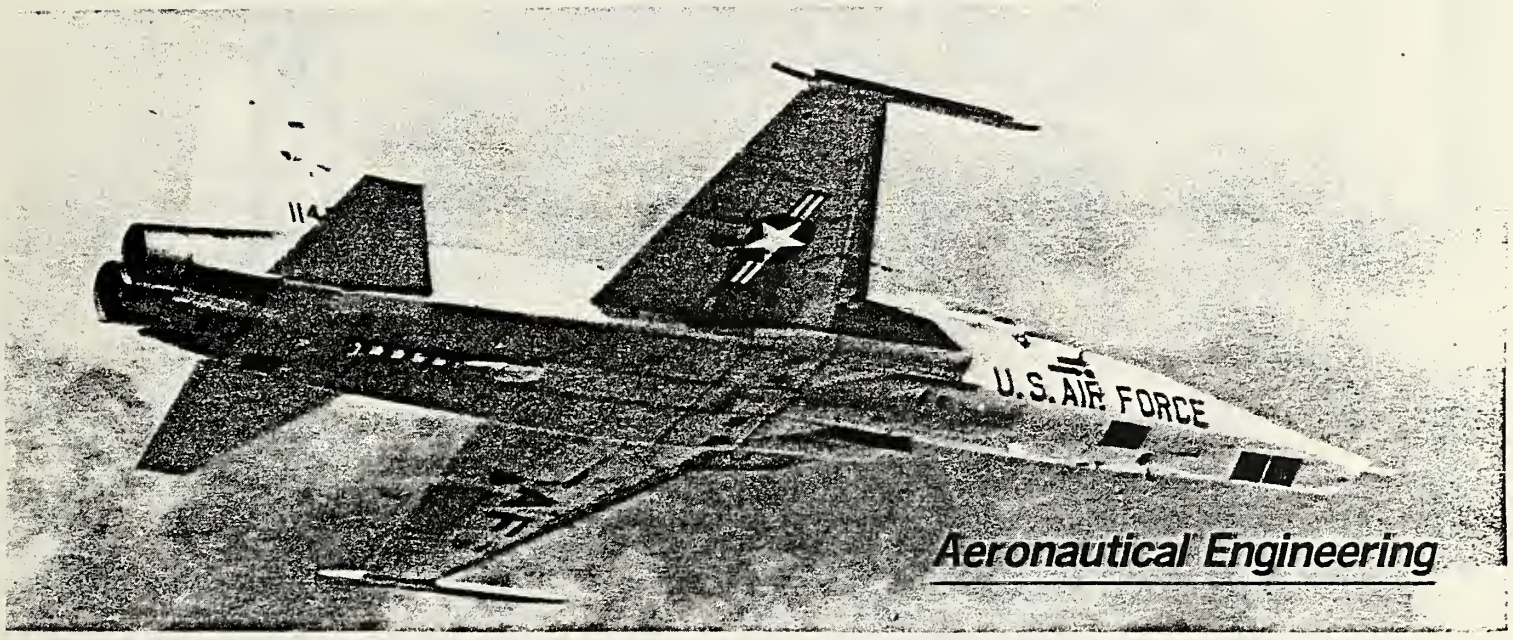
Source: Air Actualites

Venezuela. Final deliveries were made in January 1974, with a total production by Canadair of 240 CF-5's and NF-5's.[66]

Improvements over the U.S.-built MAP version of the F-5 include: the higher thrust G.E. J85 engines; improved avionics; inflight refueling system; bird resistant windshield; a lead computing sight and anti-ice windshield and inlets.[67]

Canadair also produced the reconfigured CF-5 for the Royal Netherlands Air Force, which is designated the NF-5. The NF-5 is similar to the CF-5 but with improvements consisting of maneuvering flaps, 275-gallon tanks, and an advanced navigation system which uses roller map display, a navigation computer and Marconi Doppler radar.[68]

The NF-5 is built under a cooperative program between Fokker and Canadair that is simpler but otherwise basically similar to those included in the category of multinational licensed production (Mode #2). The Netherlands original selection of the F-5 was heavily influenced by an agreement with Belgium to produce the aircraft under a joint arrangement, as they had with the Meteor/Derwent in the late 40's early 50's and the Hawker Siddeley Hunter between 1955 and 1958. But when, as an example of the difficulty of coordinating such an effort, Belgium delayed its decision beyond the time limit established by the Netherlands, the Dutch were forced to look elsewhere for an F-5 purchase agreement that would still give them a share of the production. The NF-5 agreement with Canadair was reportedly not entirely satisfactory to the Dutch, but it did provide a major amount of airframe work for Fokker. Fokker builds



Aeronautical Engineering



(ATPAA)

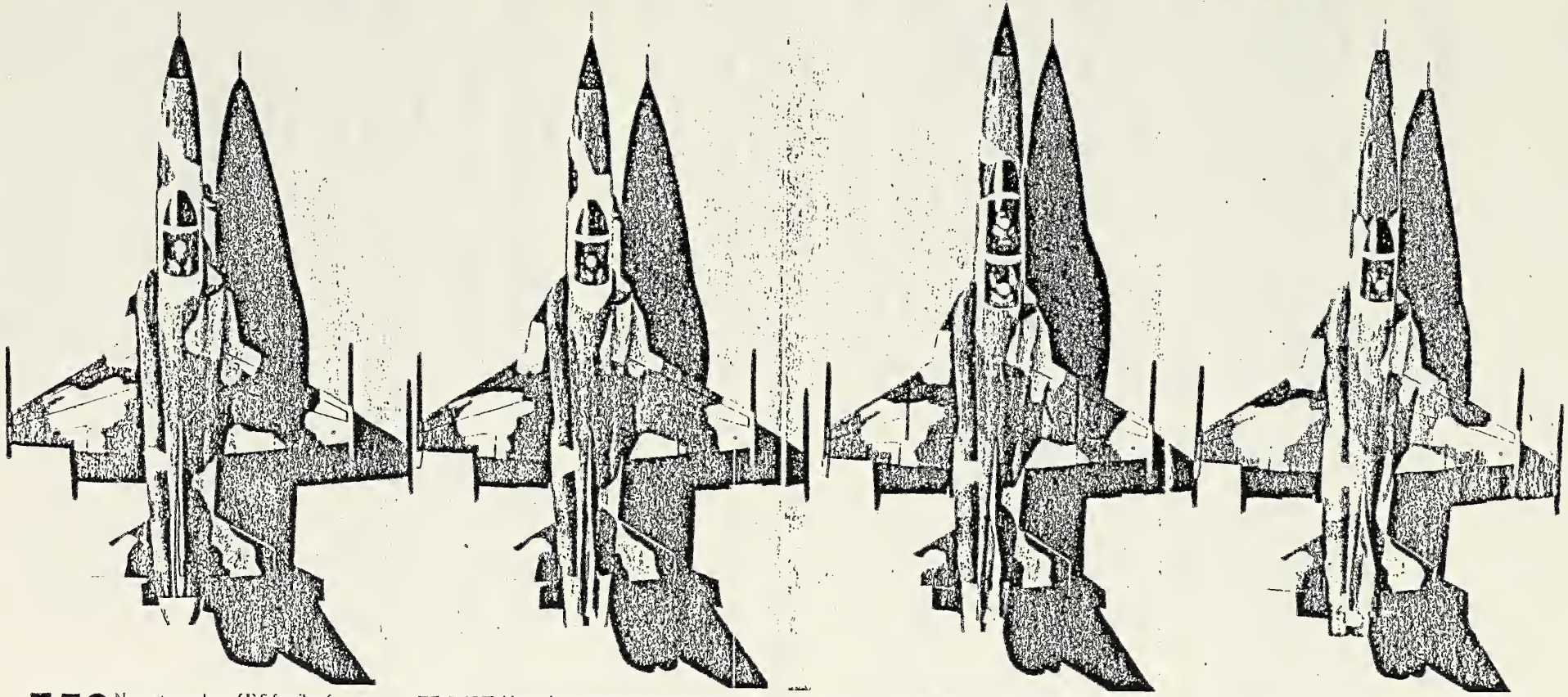
a major portion of the fuselage, while the aircraft are assembled in Canadair's Montreal factory.[69]

The Belgians were ultimately lured away from an F-5 selection by a more attractive 70% internal and external offset arrangement offered by Dassault in return for the purchase of 88 Mirage 5's.[70]

The transfer of NF-5 aircraft from Canada to the Netherlands was accomplished by the Royal Netherlands Air Force pilots, flying the aircraft to the Netherlands from the Canadair, Ltd. plant in Montreal by a series of transatlantic ferry missions. From taking delivery of the planes in Montreal, the pilots flew them in a series of steps to the Netherlands, via Bagotville, Quebec; Goose Bay, Labrador; Sondrestrom, Greenland; Keflavik, Iceland; Lossiemouth, Scotland; and finally to Twenthe, Netherlands.[71]

Improvements incorporated in both the CF-5 and NF-5 aircraft were paid for by the using governments, but Northrop retains the design rights on the changes so that they can be offered on F-5's for other countries.[72] Many of these same improvements were incorporated into the F-5E model which was named the winner of the International Fighter competition in November, 1970. This competition resulted from the USAF's plan for an improved aircraft that would be a true competitor of the MIG-21 in the foreign market.[73] Other competitors were a stripped version of the McDonnell Douglas F-4E, a modified Lockheed F-104 called CL-1200 and an updated Vought F-8 designated V-1000. The F-5E's armament consists of two 20mm M61 Vulcan cannons, with 560 rounds, and two AIM-9 sidewinder missiles.

A FAMILY OF FIGHTERS



F-5G Newest member of F-5 family of tactical fighters and trainers. Designed to meet emerging worldwide needs for defense through the turn of the century.

A single General Electric F-404 engine replaces twin J 85 engines of earlier F-5s. Result: 60 percent increase in available thrust. Mach 2 class.

F-5E Air-to-air combat superiority over anticipated threats. Air-to-ground capability fulfilling user needs. Easy maintenance. Rapid turnaround. All at affordable cost.

F-5F Fighter/trainer with two cockpits, dual controls for advanced pilot training. Retains full tactical capability.

RF-5E Dedicated reconnaissance version of F-5E. Retains air-to-air and air-to-ground capabilities.

Northrop's F-5/T-38 family. Operational flexibility. Logistics commonality. Established worldwide support system. More than 3,400 aircraft in service or on order for 28 nations.

NORTHROP

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3. The Northrop - Canada Dispute

At the beginning of 1974, after almost three years of unsuccessful negotiations, Northrop filed a suit against the Canadian government with the Toronto Registry of the Federal Court of Canada for $17.5 million. The suit was for damages and payments it contended that it was owed from the licensed production in Canada of the CF-5 by Canadair. The primary impetus behind the suit was the Canadian government's sale of the 20 CF-5's to Venezuela in late 1971. The CF-5 deal was evidently consummated after considerable foot dragging by the U.S. State Department prevented Northrop from selling F-5's directly from the U.S. Northrop contended that the sale was in violation of the license agreement with the Canadian government.[74]

Concurrent with its announcing the suit, Northrop also cancelled the licensed production agreement for any further production of the CF-5. This revocation did not apply, however, to CF-5's already under production or to spare parts for the Canadair-built aircraft.

Northrop also contended that it was due royalties and payments on the total Canadair program of 240 CF-5's and NF-5's. The royalties and payments that Northrop claimed it was due under the contract terms, had been withheld by the Canadian government for almost three years, since the beginning of the negotiations between the Canadian government and Canadair to resolve production problems and increased costs. The Canadian government had agreed to a settlement in June, 1972, providing for additional payments to Canadair.

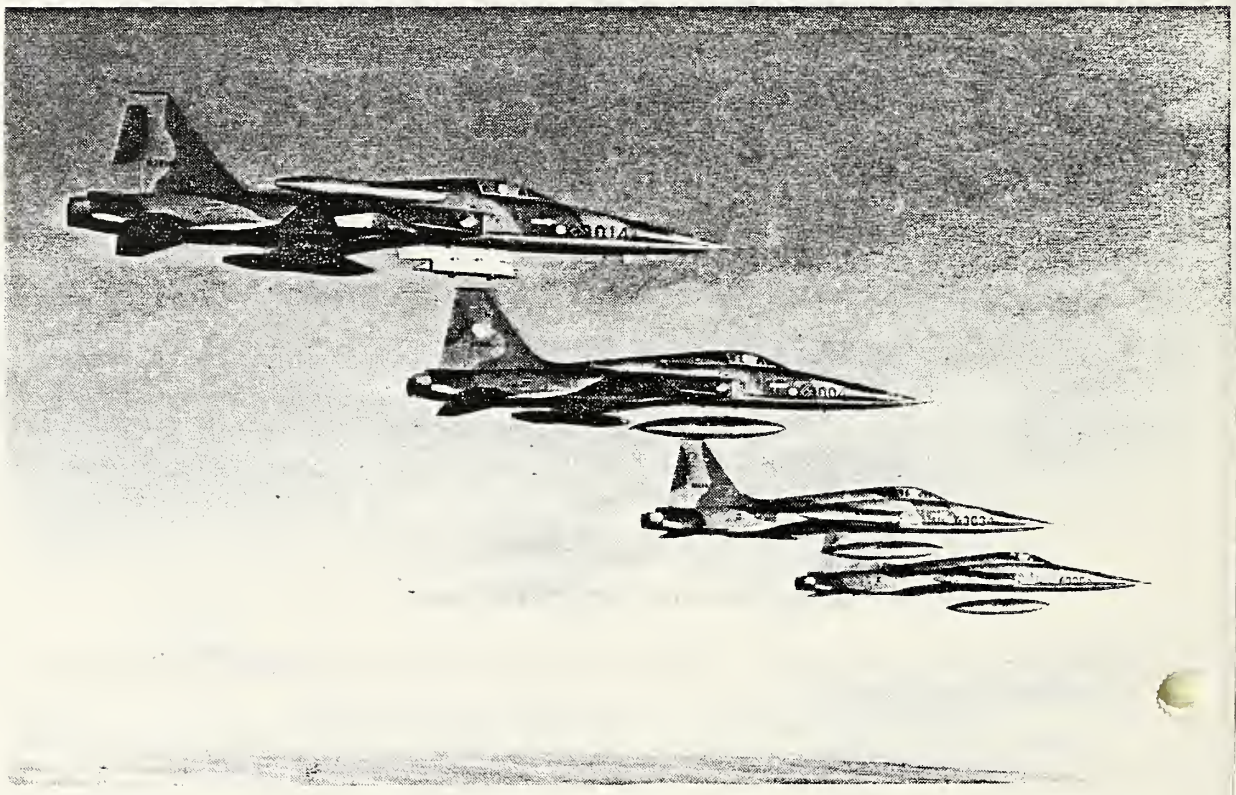
After June, 1972, the Canadian government took the position that Northrop should reimburse it for the cost of the added payment to Canadair. Northrop claimed that it was not a party to the settlement and that the Canadian government had refused Northrop's offer of assistance in the negotiations that led up to the settlement.[75]

The Canadian government's position had been that its production difficulties were due to failures by Northrop to provide adequate and timely manufacturing data and assistance to Canadair under the license agreement. Canada claimed that delays by Northrop in providing the design blueprints, technical know-how and modifications from the basic F-5 to meet the varying specifications for the CF-5 and NF-5 cost the government several million dollars in supporting a Canadair payroll for idled workers over an extended period of time. This became the basis of a countersuit by Canada.

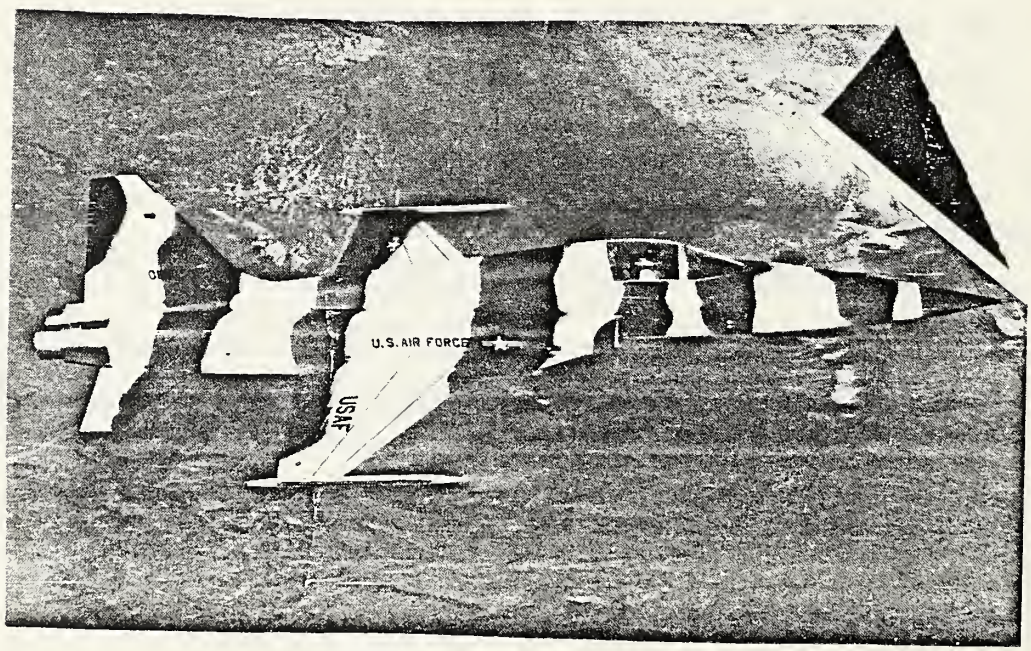
The Canadian government had previously expressed its willingness to release the royalties and payments claimed by Northrop, if the U.S. firm would agree to reimburse the government for a portion of the costs incurred because of the delays.

Canada contended that the delays—stemming from Northrop's failure to release manufacturing data on time, at times up to 10 months behind schedule, and from release of deficient data, cost the government approximately $11.5 million. The Canadian government was withholding from the company an estimated $6.3 million in royalties and other payments.[76]

Royal Netherlands Air Force: F-5 Freedom Fighter



Source: NATO's Fiftenn Nations



Source: NATO's Fifteen Nations

In addition, the Canadian government claimed that Northrop had failed by a total of about $25 million (i.e., some $30-32 million as opposed to $55-58 million) in its obligation to provide subcontract work to the Canadian aerospace industry as an external offset, as stipulated in the CF-5 licensed production contract.

In July 1976 Northrop and the Canadian government settled out of court, with Northrop receiving about $9 million on its 1973 claims against the Canadian government. Simultaneously, Canada withdrew its counterclaim against the company filed in February 1974 for $26.9 million, as part of the settlement.

4. SF-5

Construcciones Aeronauticas, S.A. (CASA) also signed agreements during 1965 to produce 70 SF-5's, the Spanish designation, under license for the Spanish Air Force, thus becoming the second firm to produce F-5's under license. Production started in early 1968 and was completed in 1971.

After subsisting largely on overhaul and maintenance work for the previous 14 years, CASA, representing 80% of the 5,000 man Spanish aerospace industry, attempted to establish a world wide manufacturing reputation beginning with licensed production of the F-5. The estimated 3 million man-hours of work represented by the SF-5 production was the first step toward modernizing the industry. This was followed in early 1970 by an offset agreement for the purchase of 30 Mirage 3's that would provide it another 6.3 million man-hours of work, as well as Spanish Government approval to build two prototypes of its



Le Northrop F 5 et le T 38 Talon ont été vendus à 30 pays (Northrop).



Au-dessus de la Cordillière des Andes, un F5 chilien (Northrop).

18-passenger STOL C.212 Aviocar transport.[77] Since then, CASA has gone on to become a partner in Airbus Industrie.

CASA built the MAP model of the F-5, 36 two-place F-5B's and 34 single-seat F-5A's. The price of the SF-5 was reportedly only 60% of the comparable U.S.-built aircraft.[78]

More technical support was needed for CASA than Canadair, the latter firm having had considerable experience in producing sophisticated aircraft. With CASA's licensed production requiring closer control by Northrop over the fighter's design, the American firm provided five engineers, 17 specialists and one pilot for a total of 430 man-months.

Metal for tooling and rigs for the SF-5 came from Spanish vendors, but raw material for aircraft structural elements was supplied from the U.S. Installing the $9.5 million in tooling consumed one million man-hours.[79]

CASA's limited experience in building supersonic aircraft led to CASA's assembly of the first eight aircraft (all being F-5B's) from components built in the U.S. The ninth model was the first of all Spanish construction. The first eight SF-5's were assembled in three graduated degrees of complexity. The first two aircraft were sent to CASA as 20 major components each. The next three consisted of 130 components each and the third stage included the assembly of three aircraft from detailed parts.[80]

About 30% of the price of the aircraft was represented by the two General Electric J85 turbojet engines, which were shipped to CASA for installation.[81]

E. CH-53G

In April 1968, after a long competition between Sikorsky's CH-53 (USN and USMC) and Boeing-Vertol's CH-47 (USA), the German government finally selected the CH-53D as best meeting the requirement for a medium transport helicopter for the German Army. The German medium helicopter program—as the RF-4E program shortly to follow it[82]— involved the balancing of the requirements to offset U.S. troop costs in the FRG and the need of the German aerospace industry to maintain a steady work load. As a consequence the CH-53 licensed production program would involve a 50-50 division of production between U.S. and German firms.

The FRG's selection of a medium helicopter involved a very lengthy competition between the Sikorsky and Boeing-Vertol entries, due to budgetary and internal political problems. The FRG first began shopping for a helicopter in this category in 1959, but as is representative of the difficulty of coordinating the scheduling of selection and production where two or more nations are involved, selection continually slipped, and the final decision was not made until April, 1968.[83]

The original plan had been for the British and Germans to make a joint buy of either the Boeing-Vertol CH-47 Chinook or the Sikorsky CH-53 involving some sort of cooperative production arrangement. The Chinook (the B model) was selected by the British in 1966 over the Sikorsky CH-53, for a 15 aircraft order but thejoint program collapsed when the FRG delayed its final decision. The UK went ahead unilaterally for several years with the planned Chinook buy

before cancelling it in 1970. In 1978 the Chinooks were reordered by the British, but this time for a quantity of 33, a requirement that has held firm (See Chapter 11).

The Bundestag Budget Committee approved the $380 procurement and co-production program for 135 CH-53's in November, 1968.[84] The German Army had been aiming for 153 of the medium helicopters, but had to settle for somewhat less. The German Army in any case had succeeded, with the help of Sikorsky's German affiliate, VFW (26.37% owned by Sikorsky's parent company United Aircraft Corp.) and Boeing-Vertol's German affiliate, MBB (9% owned by Boeing at the time), in checking a lobbying effort of the Luftwaffe against the procurement of a medium helicopter, with the aim of using the savings to buy the McDonnell RF-4E reconnaissance aircraft.[85] The German aerospace industry had in turn carried out a major compaign against the direct procurement of the RF-4E from the U.S.[86]

This choice of the CH-53 over the CH-47 was in part the result of Sikorsky's more effective marketing effort, having maintained a continual presence in the FRG and close personal contacts (including one of the Sikorsky brothers). This in turn was a function of Sikorsky's fully utilizing its broad product line in establishing and maintaining extensive working relationships with the European helicopter industries and their respective governments in the post-war period.

Vertol with a much more limited product line appeared on the scene simply for the competition and was not in as nearly a strong position from the start. Vertol also did a less than adequate job of presenting its case.

Besides having generally out marketed Boeing-Vertol, Sikorsky reportedly received better support from its German affiliate, as well as the version of the CH-53 offered being an already developed system, while Vertol's version of the CH-47, the 'C' model, existed on paper only at that time.

The basic agreement was for licensed production of 140 CH-53G helicopters, subject to patent and technology license agreements entered into by the government of the U.S. and the FRG. As part of the agreement the German Federal Ministry of Defense (FMOD) agreed to incur a pro rata share of the non-recurring development cost that had been expended by the U.S. in development of the CH-53D helicopter. The CH-53D is a configuration originally developed for the U.S. Navy, and which, with minor changes, could be adapted to the needs of the German Army, being redesignated the CH-53G. The FMOD also agreed to make every effort to achieve standardization between the two models. The standardization effort was to be directed toward ensuring equipment, component, and assembly interchangeability under cooperative logistics agreements. Pursuant to this provision, the DOD and FMOD agreed to advise each other of all applicable modifications made by either party, and to exchange the technical data necessary for their implementation.[87]

Based on the governmental MOU, a license agreement between the Ministry of Defense (MOD) and Sikorsky aircraft was negotiated in December 1969—covering

rights, fees, and dates. This license agreement granted a non-exclusive license and rights for manufacture of 133 CH-53G helicopters in the FRG.[88]

Following the conclusion of the license agreement between Sikorsky and the German Government, a number of contracts were negotiated—the work being divided approximately 50-50 between U.S. and German firms. Contracts for total production of 133 aircraft were later cut to 110 as a result of revised planning, but the contract with Sikorsky was not modified and the surplus dynamic components and flight control systems were diverted to spares.[89]

As it turned out each country built 50% of the total air frame, while 30% of the General Electric T-64 engine and 40% of the avionics were produced in the FRG. VFW was Sikorsky's logical choice as the leader of the German program, but with the FMOD having decided to spread to the German production throughout the country, contracts were signed with MBB and Dornier as well. All three German firms provided tooling, personnel, hardware, software, and training. Sikorsky built two prototypes and supplied 20 additional complete helicopters in subassemblies that German industry used as production training kits. The German Government also contracted with Sikorsky for technical advisors, instructors, pilot and personnel training, handbooks, and spares.[90]

The program proceeded without any major difficulties with the first German assembled CH-53G making its first flight in October, 1971, and with 110 deliveries having been completed on schedule by July, 1975. It was estimated that bringing German industry into the production program cost the FRG about $25 million more than if the helicopters had been bought off-the-shelf in the

U.S., but this also allowed for the supplying of German industry with somewhat under $200 million in work, or paying, very roughly, a 6% premium to the total cost for licensed co-production.[91] This small increase in cost over off-the-shelf procurement can in good part be attributed to the fact that only about 1/2 of the system was built in the FRG as second source, thus allowing for greater flexibility and a more rational approach in 'make or buy' decisions.

As contemplated in the MOU an active product improvement program was maintained. Initially the Germans simply followed the lead of the U.S. Navy and incorporated changes that had been initiated and developed in the U.S. But over the last several years the Germans seem to be occasionally taking the initiative in product improvements, suggesting that they have mastered the technology.[92]

Comments by major interested parties on the program were almost universally favorable. Although the selection involved a rather lengthy process, the CH-53G program was another case of the successful licensed production of a U.S. system in Western Europe.[93]

F. COMMERCIAL LICENSE PRODUCTION OF THE BOEING VERTOL CHINOOK BY AGUSTA IN ITALY—The EMB-CH47C PROGRAM

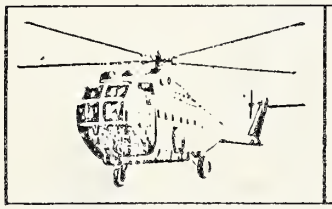
1. Introduction

The Vertol division of The Boeing Company has been involved in two major licensed production programs over the last two decades. The first was with Japan's Kawasaki Heavy Industries (KHI) since 1960 for the production of the KV-107-2 variant of the Model 107, another version of which was bought by the U.S. Navy and U.S. Marine Corps as the CH-46 Sea Knight. The second was with Agusta S.p.A. in Italy since 1970 for the medium-lift U.S. Army/Vertol CH-47C Chinook, designated the EMB-CH47C.[94]

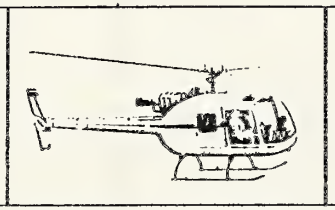
Licensed production of the C Model of the CH-47 by Agusta took place between two private firms, without government to government agreements. As in any commercial licensing agreement, be it for toasters, automobile parts, computers, or aircraft, Vertol, the licensor, supplies the technical data package and corresponding industrial property rights, technical assistance, parts, and so forth. The licensee provides the facilities, tooling, personnel, and the balance of the effort to manufacture the product and market it in its prescribed territory. Each of the two parties manufactures for its own requirements, with their respective governments performing only as regulatory bodies. The governments are not participants, there are no MOU's, no umbrella agreements, no consortia.[95]

Licensed production has been especially heavily resorted to by U.S. helicopter manufacturers in their marketing efforts in Western Europe and East Asia.

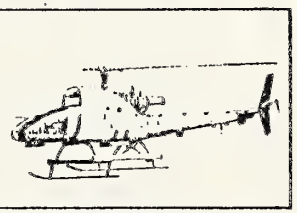
AGUSTA DEVELOPS



AGUSTA 101 G first flew in October 1964. It remains as one of the largest helicopters completely developed in Europe. Gross take-off weight in excess of 28,000 pounds. Carries 35 passengers. This five-bladed helicopter was powered by three Bristol Siddley Gnome 1400 h.p. engines.



AGUSTA 105 B first flew in April 1965. Four-seat utility helicopter powered by the TAA-230. Maximum gross take-off weight of 2,750 pounds. Designed for a wide range of civil and military duties including reconnaissance, liaison, light transport and training.



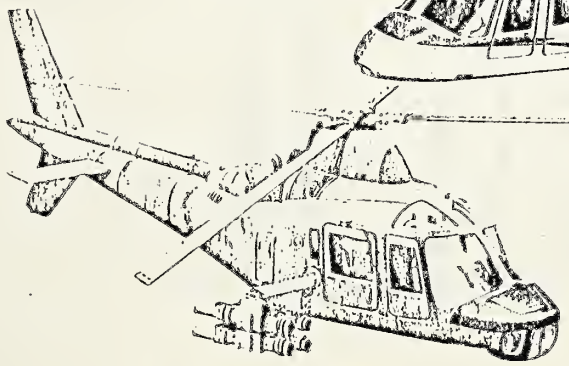
AGUSTA 106 first flew in November 1965. Single-seat helicopter for the ASW mission. Powered by a TAA-230 engine. Two-bladed with 3,000 pound gross take-off weight. Successfully deployed in the Italian Navy.



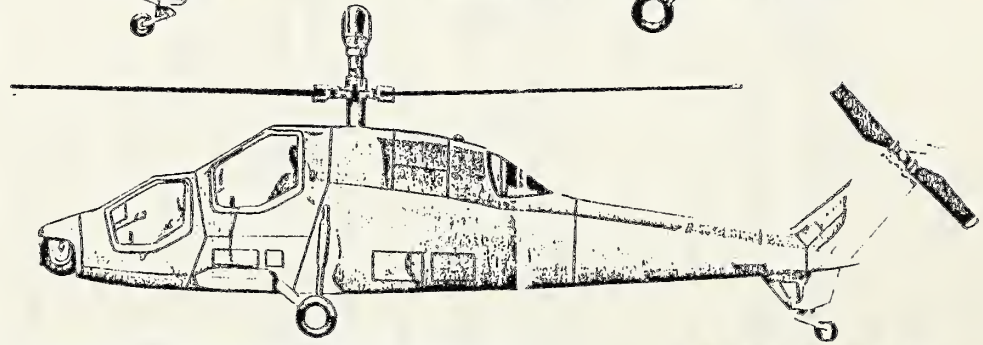
AGUSTA 129 Lightweight Multimission Combat Helicopter under development for the Italian Army in anti-tank version. Carries 8 TOW Missiles or 52 2.75" Rockets. Features: Four blades fully articulated ☐ Ballistic tolerance (12.7mm API) ☐ Crashworthy (MIL-STD-1290) ☐ Fiberglass Main Rotor Blades ☐ Full ASE Suite ☐ Twin Engine Rolls Royce Gem-2 – Future – ATDE



AGUSTA 109 first flew in August 1971. High performance, four bladed advanced utility helicopter powered by two Allison 250 C20B engines. This eight-place helicopter is in full production for both military and civil applications in over ten countries. First helicopter fully FAA certified for single pilot IFR flight.



AGUSTA 109/TOW adapted for military application with U.S. Army/Hughes Aircraft M-65 TOW Missile System. Extraordinary stability as a firing platform. Achieved 100% target hit record throughout extensive firing trials. Functions as superb fast utility helicopter when not used in anti-tank capacity.



AGUSTA 129 Scout. Maintains all features of the attack version. Already designed to accommodate a Day/Night Mast Mounted Sight and the Air Defense Suppression Missile System. Performs with the AH-64 in all mission environments. Meets U.S. Army/USMC ASH requirements.





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Particularly noteworthy have been the many agreements of Sikorsky and Bell:[96] the former firm in France, the FRG, Italy, and especially the U.K.; and with the latter's licensing agreements concentrating heavily on Italy and Japan.

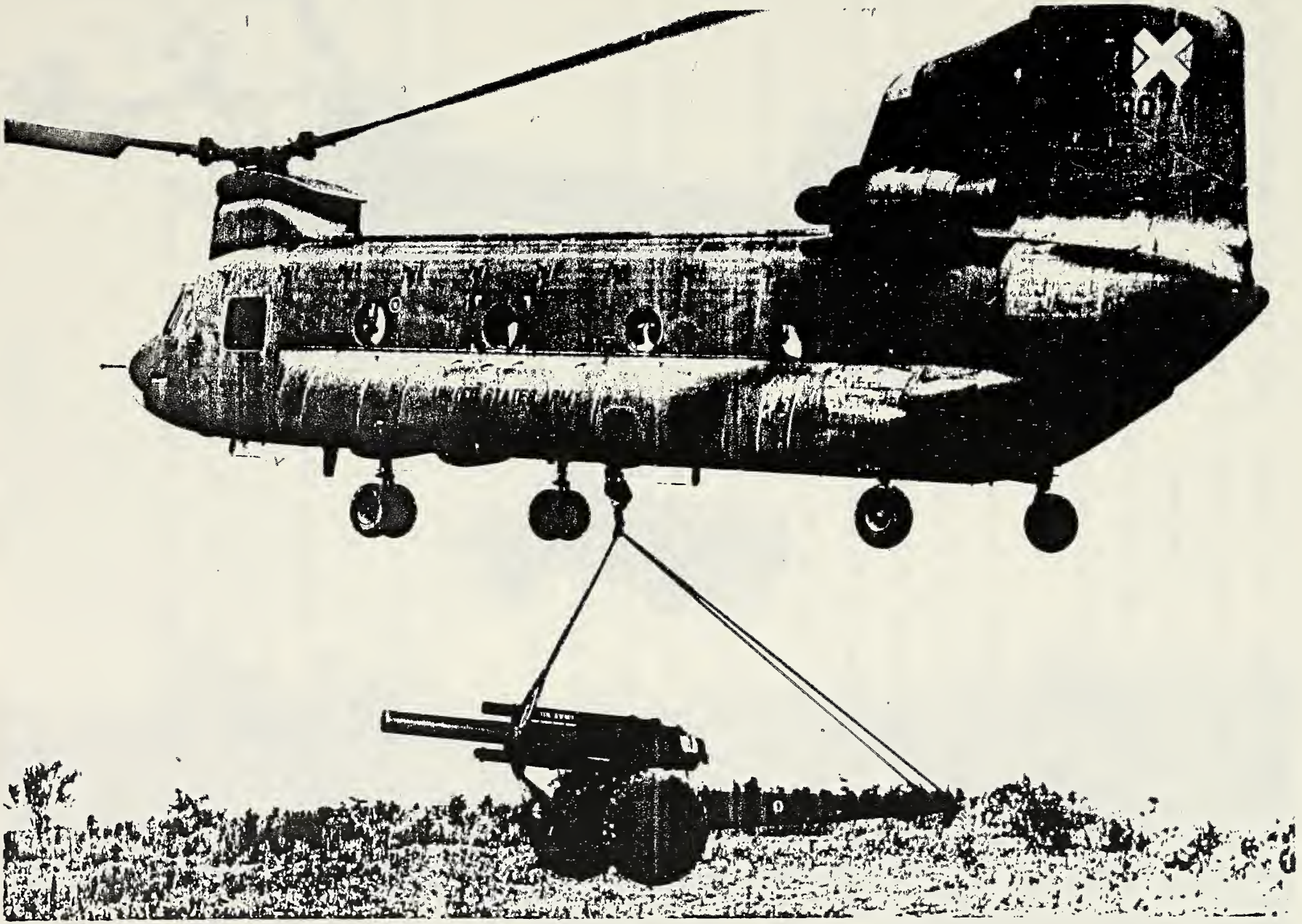
One Italian firm in particular, Agusta, has traditionally specialized in the manufacture of U.S. helicopters under license. In spite of the more recent appearance of the light weight A-109 and A-129 anti-tank, scout and utility helicopters, which represent its first series production ventures into internally designed products, Agusta has continued to receive a steady flow of orders from both domestic and export customers for the various Bell, Boeing Vertol, and Sikorsky helicopters that it produces under license. Its success with licensed production has convinced Agusta management to continue to rely heavily on this line of activity while it seeks to expand its activities in the areas of design and development. As the UK's Westland Helicopters, France's Aerospatiale, and the FRG's MBB have been moving increasingly towards European helicopter consortia excluding U.S. firms, Italy's Agusta has been dragging its feet somewhat, preferring to maintain its profitable transatlantic relationships, as well.[97]

2. The U.S. Army's CH-47 Program

Boeing Vertol's Model 107 prototypes were originally designed to fill a U.S. Army requirement in the late 1950's for a turbine-powered helicopter to replace its piston-driven helicopters operating in the personnel and equipment transport role. With preliminary development beginning in 1956, the first flight of the Model 107 was in April 1958. The U.S.M.C. and U.S. Navy were later to buy a variant of the Mode 107 as the CH-46. Meanwhile an improved and considerably larger version of the Model 107 with uprated engines and incorporating other improvements, underwent Army evaluation during 1959, and was purchased by the service as the CH-47. Initial contract award from the U.S. Army's Troop Support and Aviation Materiel Readiness Command in St. Louis, Missouri came in June 1959. The first flight was in September 1961, and the first CH-47A was delivered to the U.S. Army in mid-1962. The first U.S. Navy/U.S.M.C. order for the CH-46A came in February 1961, with first flight in October 1962 and first delivery the following year.[98]

During the 1960's three variations of the CH-47 appeared. Following up on the A version, the CH-47B first flew in October 1966 and was first delivered in May 1967. The first CH-47C flight took place in October 1967 with first deliveries beginning in the spring of 1968.

The initial production version, the CH-47A, was basically an enlarged version of the CH-46 Sea Knight. Original versions had two Avco Lycoming T55-L-5 turbo-shafts with a shaft horse power (shp) of 2,200, but later changed to T55-L-7's. The T55-L-7B's each had 2,650 shp.



Source: Boeing U.S. Army CH-47A

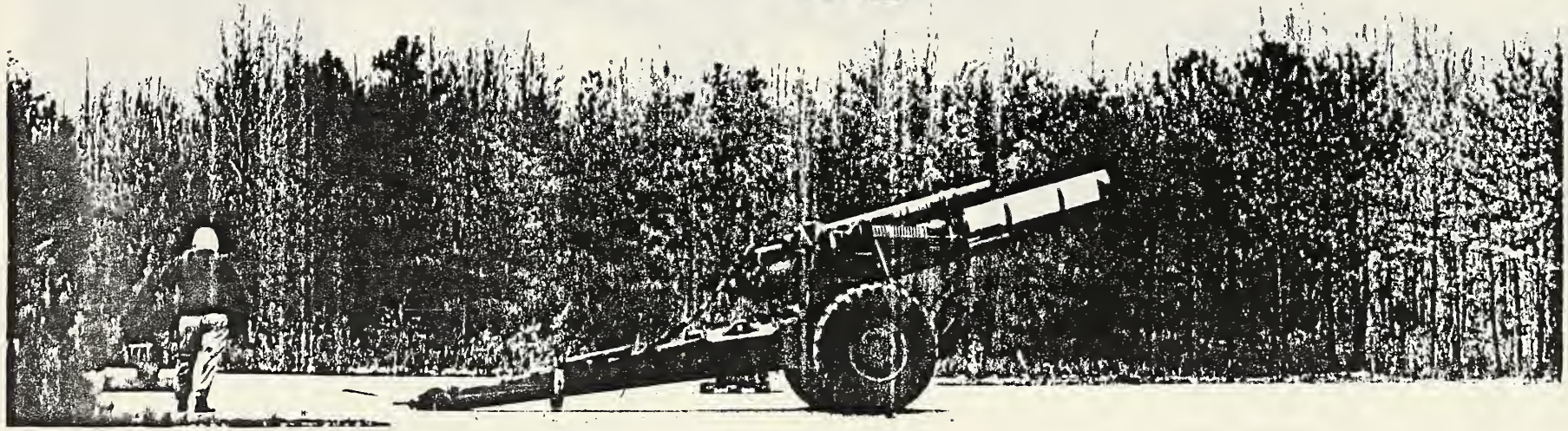
The CH-47B features a more powerful engine, the Avco Lycoming T55-L-7C turbo-shafts with 2,850 shp each, as well as redesigned rotor blades, blunted rear rotor pylon and other improvements. The CH-47C utilized yet more powerful engines, the T55-L-700's with 3,750 shp each, along with strengthened transmissions, and increased fuel capacity.

The original production run encompassing the three versions of the CH-47 for the U.S. Army continued up through FY 1971, by which time over 700 of the aircraft had been produced at the Philadelphia facilities of Boeing's Vertol division. Although there were to be several intermittant U.S. buys later during the 70's, the decade saw the Boeing Vertol CH-47 program living primarily off of exports, be they direct, or indirect through the intermediary of their Italian licensee.

The U.S. purchases involved an FY 1974 buy of 24 aircraft by the Air Force as paybacks to the Army for units transferred to the South Vietnamese,[99] followed by an FY 1976 Army purchase of 12 units for $36.4 million, plus an FY 1979 buy of 8 units for $33.0 million, both for the U.S. Army.

In any event, it was the shift in focus at the beginning of the 70's to the export market that allowed the U.S. production line to keep going throughout the 70's, be it at a lower rate, until U.S. Army requirements picked up again in the early 80's. Though representing an extreme example, Vertol's experience in this regard was similar to the industry wide trend. While procurement by the U.S. Armed Forces dropped from a high of $44 billion in 1968 to a low of $17 billion in 1975 (in constant dollars), foreigh sales for the U.S. defense industry increased over



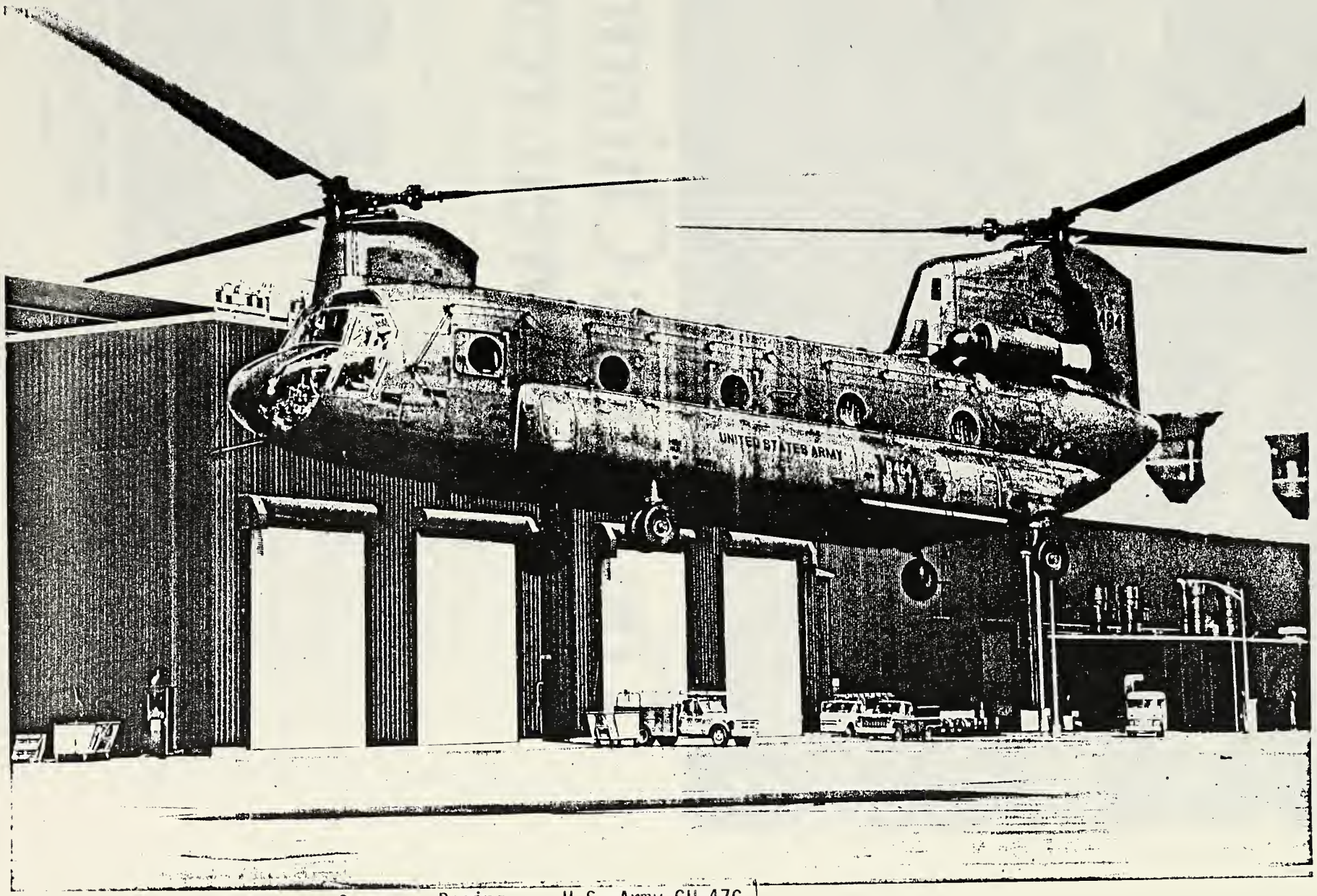


Source: Boeing U.S. Army CH-47B

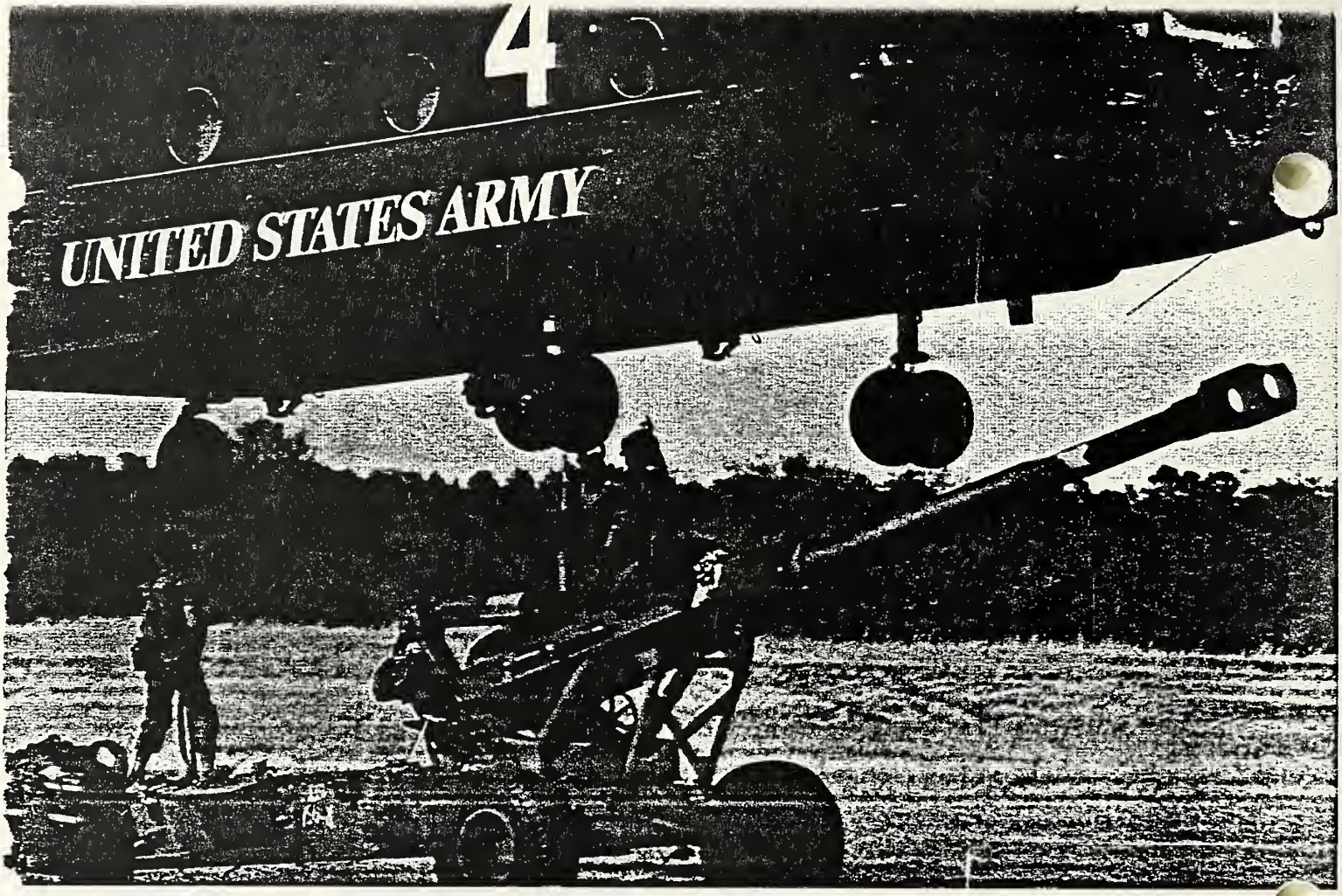
the first half of the 1970's from $1.5 to over $14 billion a year. Foreign sales of the Chinook will be covered in the next section of this subchapter.

By the beginning of the 1980's the customer base of the CH-47 was starting to shift back toward the U.S. military. On October 24, 1980, after having successfully passed DSARC III for production approval, Boeing Vertol was awarded an initial $103 million contract for modernization of the U.S. Army's CH-47 Chinook fleet to the D configuration. Total estimated cost for the program is approximately $3.1 billion (in then-year dollars) and is to include the modification of 436 existing Chinooks over a 12 year period.[100] Service lives of these aircraft will be extended beyond the year 2000. The initial $103 million award provided for modification of nine CH-47A's to the D configuration, procurement of long lead items for an additional 19 helicopters during FY 82, and assorted non-recurring production costs. The Army's program envisages the modernization of three aircraft per month from late 1980 through 1991.[101]

The U.S. Army found that Chinook modernization was far more cost-effective than development of a new helicopter to support the Army's medium lift requirements. Boeing Vertol began development of the CH-47D version of the Chinook in 1975 with engineering development of transmissions, hydraulics, and fiberglass rotor blades. Boeing Vertol was awarded a $71.3 million engineering development contract in early June 1976, to design, fabricate and demonstrate seven systems (excluding the engine) in three prototype aircraft (one CH-47A, one CH-47B, and one CH-47C). Avco Lycoming received a separate modernization contract in late July 1976. The first three converted aircraft each



Source: Boeing U.S. Army CH-47C



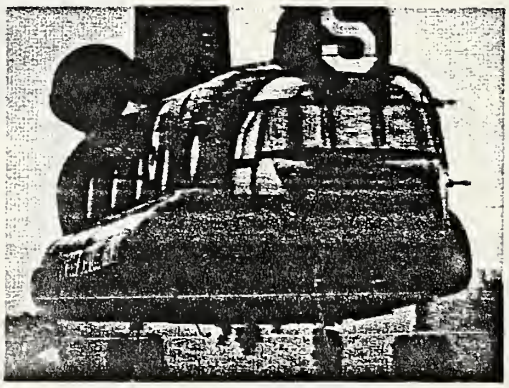
The Army's Chinook D: tested, proven, ready.

The remanufactured CH-47D continues to perform as promised. With the U.S. Army and Boeing Vertol working as a well-disciplined team, the project has stayed on budget and ahead of schedule all the way.

Now, comprehensive developmental and operational testing has been successfully completed. With over 900 test hours flown, payload performance is conservatively rated at 1200 pounds *over* guarantee. Systems reliability, hardware reliability, and maintenance man-hour goals have been met or exceeded.

The advanced Chinook is ready for full production. The Army's need for a modern medium-lift helicopter can be met at a savings of hundreds of millions of defense dollars. And with a bonus in operational capability.

The Chinook D. Still on schedule, still under budget. And now...tested, proven, and ready.



BOEING VERTOL HELICOPTERS
THE LEADING EDGE
Philadelphia, Pa. 19142

had its initial flight between May and August 1979. The prototypes were delivered to the Army at the end of 1979 and in early 1980, with Operation Test and Evaluation carried out that spring. The first of the series CH-47D's is to be delivered to the Army in May 1982.[102]

Improvements incorporated in the CH-47D encompass:

- improved transmissions (7500 shp rating)
- redundant and improved electrical systems
- fiberglass rotor blades
- Avco Lycoming T55-L-712 engines with emergency power
- modularized hydraulic systems
- triple cargo hook suspension system
- an advanced flight control system (AFCS)
- improved avionics
- aircraft survivability equipment
- single point pressure refueling system
- improved T-62T-2B auxiliary power unit (APU)

In addition to the CH-47D modernization program the Army has funded two separate modification efforts for the "C" models, spanning the period of FY 78 through FY 84. The metal rotor blades are being replaced on some 210 CH-47C's by fiberglass blades under a series of contracts with Boeing Vertol totaling $67.2 million. This will not only be less expensive than replacement by metal blades but will improve safety and reliability while reducing maintenance hours for the fleet. Under a series of contracts totalling $63.8 million with



Source: Boeing U.S. Army CH-47D

Avco Lycoming, the T55-L-11D engines on these CH-47C's are being converted to T55-L-712's.[103]

On top of these modernization programs the U.S. Army is planning the procurement of an additional 138 CH-47D's during the late 1980's and early 1990's.

In addition to Lycoming for the engine, Boeing Vertol's top suppliers include:

Solar	-	auxiliary power unit;
Litton	-	transmission;
Lored	-	landing gear;
Honeywell (Minneapolis)	-	automatic flight control system;
Fenn Manufacturing	-	Rotor hub parts.

3. World Sales

For license production of the Chinook in Italy, negotiations between Agusta and Boeing Vertol began in 1964 and progressed slowly, with agreement finally being reached in March of 1968 at which time the two firms signed the License Agreement and Amendment #1. Amendment #1 defined the four options covering the portion of Boeing Vertol owned Chinook proprietary rights that would be granted to Agusta. The U.S. Department of State's Office of Munitions Control (OMC) approved the agreement in August 1968. The agreement became effective on February 10, 1969 upon the receipt by Vertol of Agusta's first payment. Amendments #2 and #3 were incorporated simultaneously; #2 covering the OMC's provisions for category A and B countries (to be explained shortly), and #3 updating payment terms. Implementation of the Agreement did not occur until almost one year later in mid-January, 1970. The primary factor contributing to the length of the negotiations and the final two year delay between signing and implementation was the on again off again nature of the key Italian Army order. As it was, Iran committed itself first with an initial order in late 1969 for 45 helicopters, several months prior to the Italian government's definitive commitment.

As Agusta's sales efforts outstripped its production capacity, however, a total of 45 of those helicopters sold by Agusta were actually to be built in the U.S. by Boeing Vertol. This included 17 aircraft by the time of the first delivery of a helicopter off the Agusta line, on February 21, 1975 (the original target date had been November 26, 1974). This aircraft was delivered to the Italian Army as S/N M-004. Another 28 were delivered by Vertol to



CH-47 MEDIUM LIFT HELICOPTER USERS

OPERATOR	MODEL	AIRCRAFT	FLIGHT HOURS
U.S. Army	A,B,C	732	1,636,920
Canada	147	9	18,242
Australia	C	12	12,315
Thailand	A	4	3,358
Spain	C, 414	13	6,682
Iran	C	75	18,000+
Italy	C	26	11,673
Libya	C	20	4,444

OPERATOR	MODEL	AIRCRAFT	FLIGHT HOURS
Argentina	C	3	1,193 (Air Force)
		2	484 (Army)
Morocco	C	10	—
United Kingdom	C, 414	33	483
Egypt	C	15	—
Tanzania	C	2	141
Greece	C	10	—
British Airways Helicopters	234	6	—
		972	1,713,935

Source: Boeing

Agusta through December, 1978. There have been no further such orders since the end of 1978.

World sales for the two firms (in chronological order) break down as follows for the Chinook, as of March 1982:

Boeing Vertol		Agusta	
U.S. Army[104]	731	Iran	68
Spain	13	Italy	28
Australia	12	Libya	20
Canada	9	Morocco	10
Argentina	5	Egypt	15
U.K	33	Greece	10
British Airways	6	Tanzania	2
	809		153

It is noteworthy that not only is the second production source for the Chinook in another NATO country, Italy, but six of the customer governments listed above are NATO members (or in the process of becoming one in the case of Spain). In addition, all of these NATO customers, plus Australia, have been involved to some degree in Chinook production activity with the exception of the most recent NATO customer, Greece.[105]

All of Boeing Vertol's foreign sales were commercial direct except for those to Australia and Canada, which were both FMS.[106] Moreover, four of the six—the Australian, British, Canadian, and Spanish sales were accompanied by



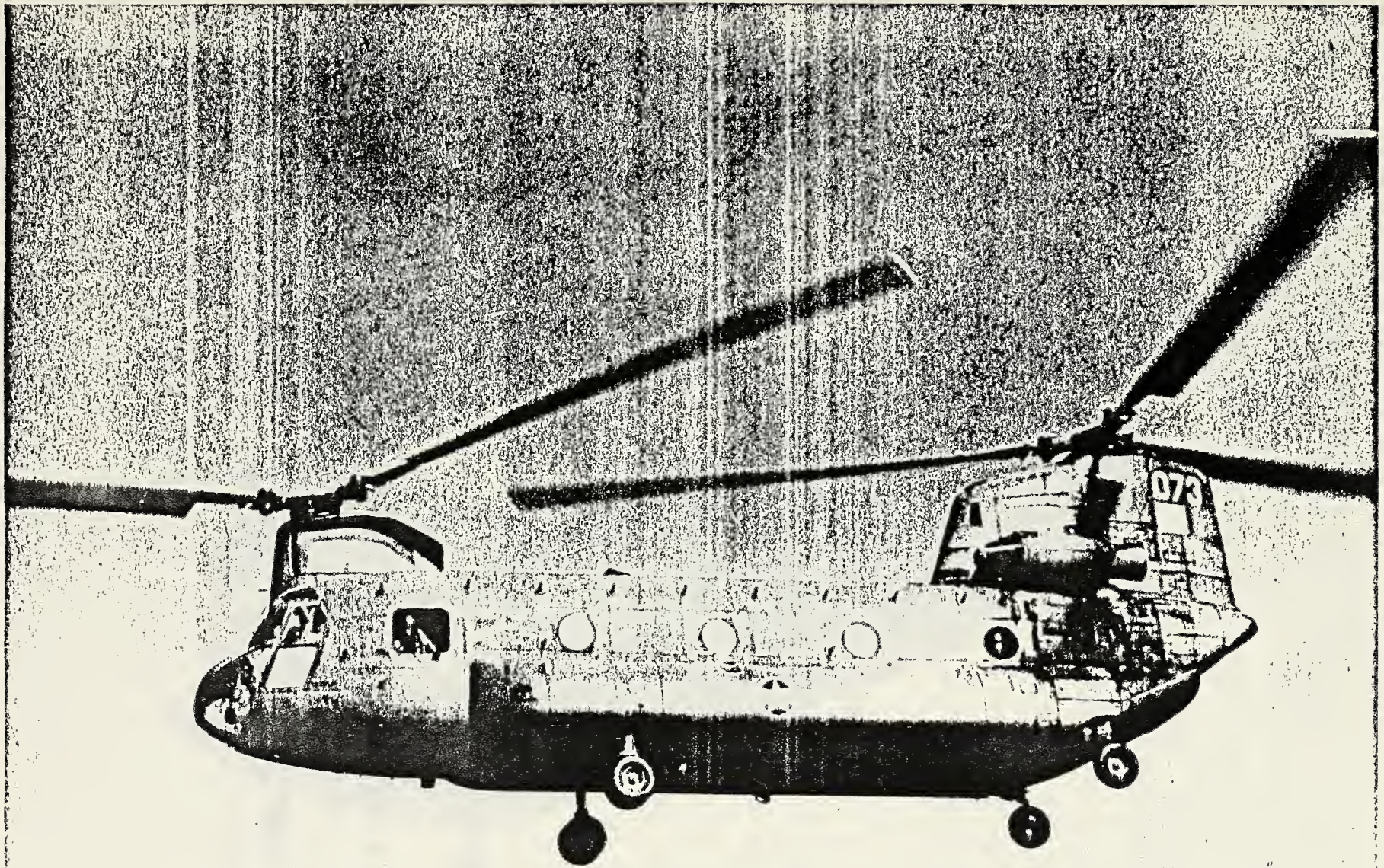
Source: Boeing Thai CH-47A

offset arrangements involving subcontracting to the purchasing nations' industries. The arrangements accompanying the British, Canadian and Spanish sales are treated in Chapter 11 under Mode #6 of industrial collaboration. As in most U.S. defense programs, Canadian industry has participated in Chinook production from the beginning, pretty much on the same basis as U.S. industry. (See Chapter 10, sub-chapter A, section 2.)

Boeing Vertol's first foreign sale, apart from those sold through the licensee, Agusta, was Spain in 1971. The original Spanish order involved only seven aircraft, but Spain bought an additional three in 1975 and another three in 1980. The offset arrangements mentioned above only applied to the latter purchase of three Chinooks. Though all were direct commercial sales, Spain has been able to utilize FMS credits for the most recent purchase of three aircraft.

The Royal Australian Air Force selected the CH-47C over the Sikorsky CH-53 in August 1971 for medium lift helicopter duties. The $44.2 million deal included a commitment by Boeing Vertol and the Boeing Commercial Airplane Company to place $8.4 million worth of offset work with the Australian aircraft industry. In fact, work passed to Australian industry as a result of this deal, will in the end well exceeded this figure. Deliveries were completed in December 1973.

Canada ordered eight Chinooks, designated CH-147, in July 1973 through FMS channels for $23,820,439. Deliveries occurred between September, 1974 and October, 1975, with one of the aircraft crashing during its post-delivery



Source: Boeing Vietnamese CH-47A

ferry flight. A replacement aircraft was purchased by a direct commercial contract for $5.4 million. The ninth aircraft was delivered in April 1978. These aircraft were a variant of the CH-47C equipped with Lycoming T55-L-11C engines and other options available by 1976. Major differences with the standard CH-47C were the internal fuel system which provided longer range, plus an automatic flight control system. As previously mentioned, Canada was also involved in a sort of offset arrangement. Canadian industry has had a minor role in the production of all Chinooks; be it through Boeing of Canada in Ontario and Manitoba, or subcontracts placed directly with other Canadian firms.

The Argentine Army expressed strong interest in the purchase of two CH-47's in 1976. Due to the Carter Administration's stand on human rights violations, however, an export license for the helicopters was not issued by the Office of Munitions Control to Boeing Vertol until September 1978. In the meantime, the December 1977 Argentinian contract with Boeing Vertol had expired. Argentina had ordered instead 12 Aerospatiale Pumas, while voicing concern over inconsistant U.S. foreign sales policies and the possibility of restrictions on parts and supplies in the future. In June 1979, however, Argentina finally agreed to go through with the purchase of two CH-47C's for the Army (both of which had been sitting in storage at Boeing Vertol) under Amendment 1 to the original contract. Another contract followed later that year from the Argentine Air Force for 3 CH-47's. In addition, the country has a stated requirement for additional Chinooks in the future for both its Air Force and Army.



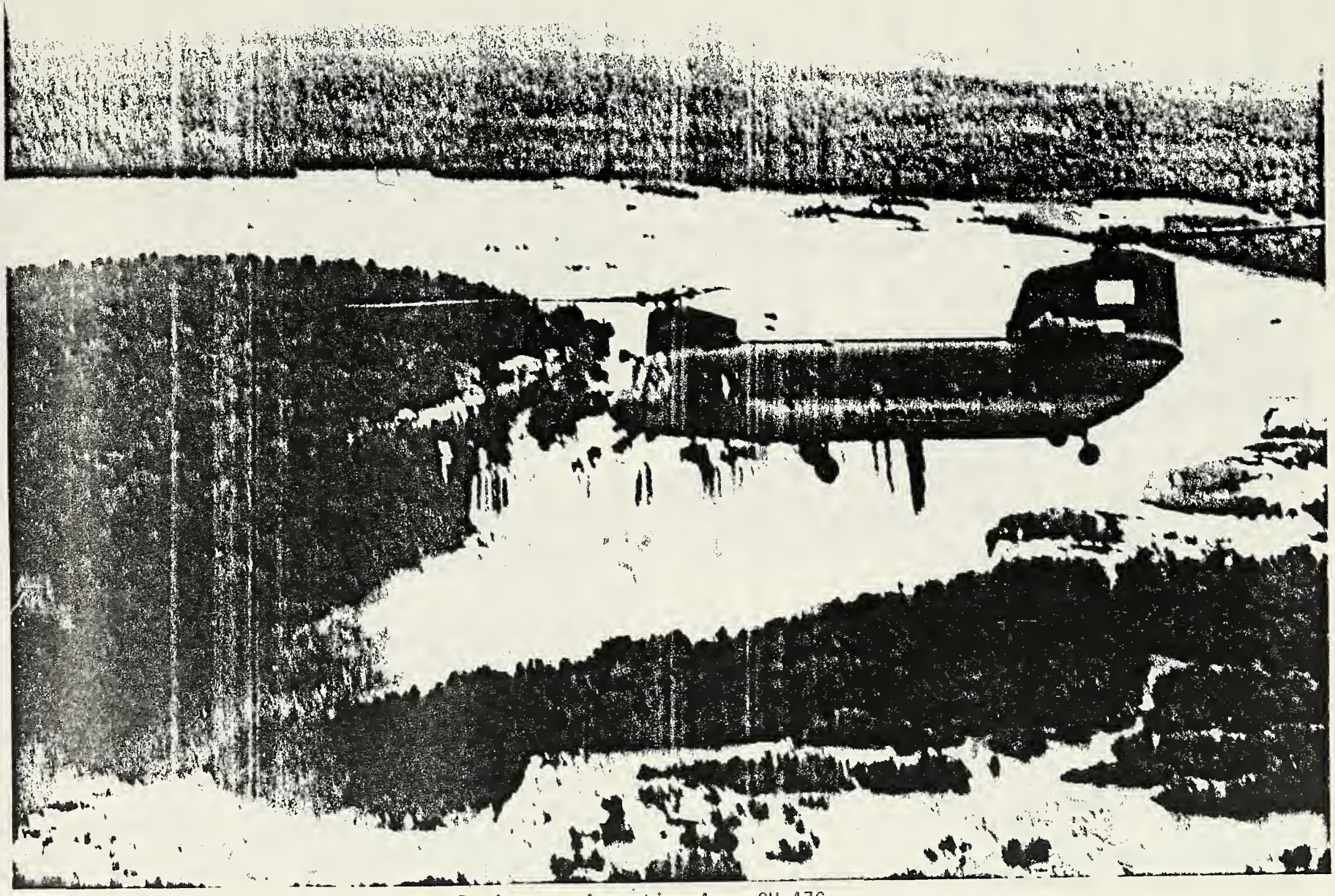
Source: Boeing Australian Air Force CH-47C

The Royal Air Force (RAF) originally ordered 30 Model 414's of the CH-47C early in 1978. In October of that year an additional three Chinooks were included, boosting the total contract value to $242.2 million. The Model 414 is similar to those delivered to Canada, offering a number of features planned for the CH-47D, i.e. it is either a C+ or D- version, depending on how one wishes to look at it. Deliveries were initiated during the summer of 1980 and continued through late 1981. As previously mentioned, the offset arrangement accompanying this sale is covered in detail in Chapter 11.

British Airways Helicopters is the first customer of the commercial variant of the CH-47; the Model 234. The 234 is the world's largest capacity commercial helicopter, carrying up to 44 passengers 565 nautical miles.

The large lift capability of the Commercial Chinook should attract utility operators and the aircraft's long range and large passenger capacity should help the aircraft garner a number of sales to offshore operators. A large number of Chinooks may be used in the North Sea where helicopter traffic is expected to grow to 225 million passenger miles as helicopters will have to travel distances of up to 390 nautical miles to the oil rigs.[107]

Japan's Ground Self-Defense Force has been considering the Chinook for over a decade for replacement of its 58 Kawasaki-built KV-107-2's currently in the inventory. Up until recently this was to involve 40 Chinooks built under license by Kawasaki. In late 1981 the effort picked up and Vertol was working on a proposal with Kawasaki for a 55-67 aircraft production run following the ground rules of maximizing Japanese content while staying within 140% of the



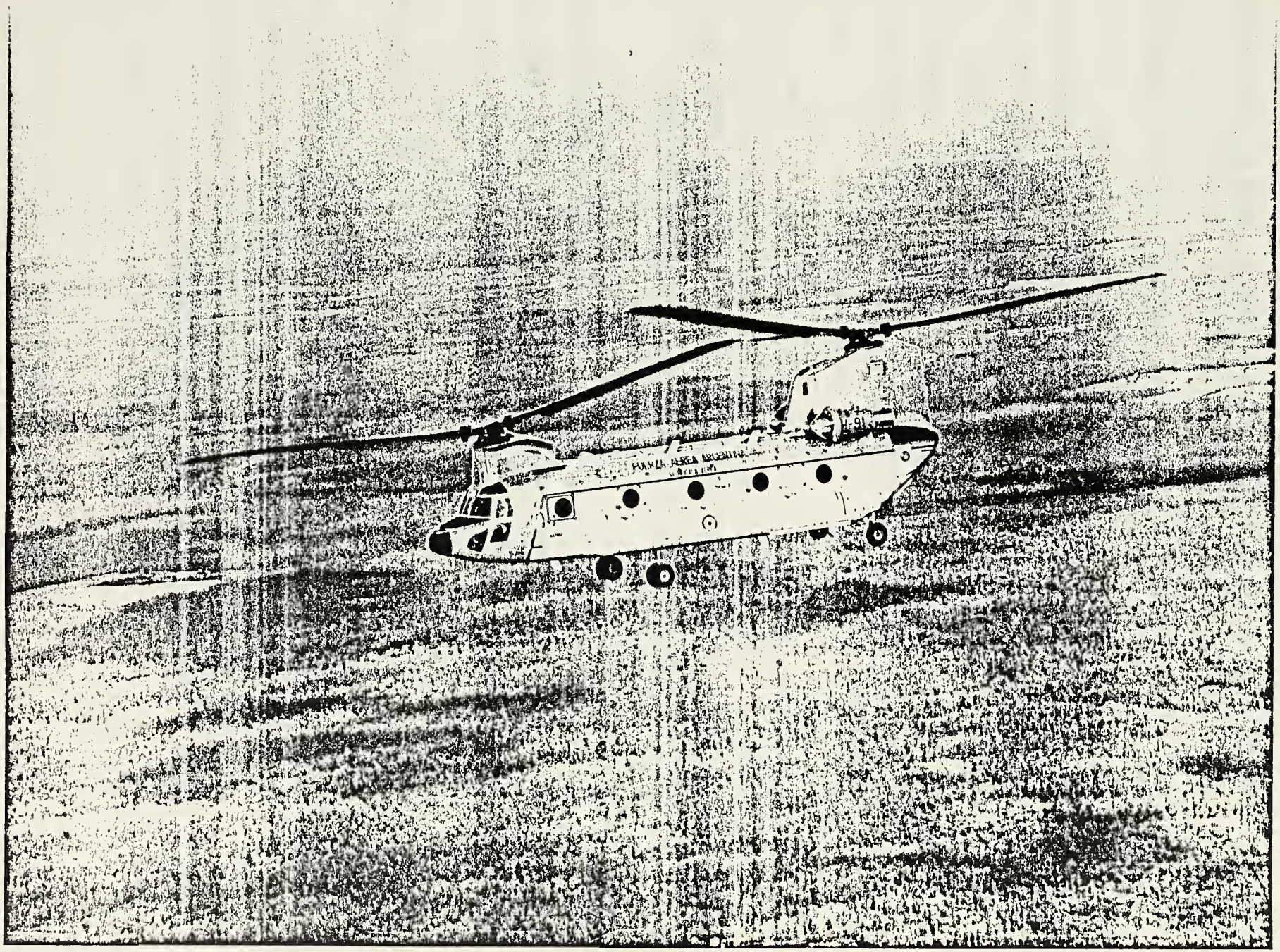
Source: Boeing Argentine Army CH-47C

Boeing Vertol price. Forty of the Chinooks (Model 414 probably) would be destined for the Ground Self Defense Forces (SDF), 15 for the Air SDF, with the possibility of another 12 for the Maritime SDF. Two of the Chinooks were to be delivered by Vertol as complete aircraft, one as a knocked down aircraft, and the balance to be built in Japan from the 52-64 shipsets of parts provided by Vertol. The fuselage would be Japanese manufactured with the exception of drop hammer and stretch form parts.

That completes the summary of Boeing Vertol sales, now for those of its licensee, Agusta. As Agusta's Principal Territory for sales lies mostly in the Middle East, a particularly turbulent and politicized region of the world, approval or disapproval by the U.S. Government is an important ingredient in each sale.

Though it was originally intended that the Italian Army order of EMB-CH47C's would provide the base upon which the second Chinook production line would be launched, in fact it turned out that Iran was to be Agusta's first customer in late 1969 with a 45 aircraft order, worth an estimated $425 million. It was to be several more months before the Italian government finally committed itself with a 28 aircraft order in early 1970, almost six years after the requirement had originally surfaced. Some 20 of these 45 Iranian Chinooks ended up being built by Boeing Vertol in Philadelphia, PA.

Iran followed up on its original 45 aircraft order from Agusta with another one for 50 aircraft in the mid-70's. Only 23 aircraft, however, from this



Source: Boeing Argentine Air Force CH-47C

second order were ever to be delivered because of the U.S. arms embargo on Iran following the November 1979 hostage crisis. In enforcing the embargo, the U.S. Government, through the State Department's Office of Munitions Control, vetoed any further transfers by Agusta.

The next Agusta sale was to be to Libya for 20 Chinooks. When the Libyans came back for a second order of 10 additional aircraft later in the 70's, the OMC was to veto the sale; U.S.-Libyan relations having deteriorated considerably in the interim, due to the latter's involvement in international terrorism.

Despite the Carter Administration's policy not to provide arms to Morocco until that country pledged not to use them against the Polisario in the Western Sahara, the OMC approved a sale of 12 Chinooks by Agusta.

Interrelated with the U.S. embargo against Iran, the U.S. government was to play a major role in providing Agusta with its next customer, Egypt. This sale was for 15 aircraft and is covered in the next section.

The sixth EMB-CH47C customer was to be to another NATO member state, Greece.

Agusta's seventh and most recent customer is Tanzania for 2 Chinooks. However, due to difficulties with financing, delivery of the aircraft has been sliding. Meanwhile, the Chinooks originally destined for Tanzania have been repainted and were delivered to Greece in late 1981.

4. The Vertol-Agusta License Agreement and its Implementation

Unlike the case of license production of the M113 APC in Italy, or the CH-53 helicopter in the FRG, both treated in previous sub-chapters, this was a purely industry-to-industry effort, neither of the two governments participating. The two governments came into the picture at the end of the process only, approving the commercial licensing agreement. On the U.S. side this involves the usual obligation to comply with the International Traffic in Arms Regulations (ITAR), administered by the State Department's Office of Munitions Control (OMC), which call for obtaining the approval of any such 'manufacturing agreement' for items on the OMC's Munitions List and the annual application for licenses to cover the continued export of packages of classified and unclassified technical data and/or hardware under the approved agreement.[108] The Basic Ordering Agreement between the two firms identifies the responsibility for clearing with the Office of Munitions Control all EMB-CH47C exports to third countries as lying with Agusta. For the approval of Agusta marketing activities in any given nation, Agusta's Washington D.C office submits the necessary forms to the State Department. However, for the export of hardware and technical assistance, Boeing Vertol carries out this function for its licensee.

Since this is a commercial transaction (though still one involving a Munitions List[109] item), outside of the DoD's Foreign Military Sales (FMS) process, there was naturally no administrative fee paid to the U.S. government. The usual R & D recoupment charge was assessed, however, amounting to $59,700 per helicopter for Agusta's first two customers, Iran and Italy. For all later

customers the R&D recoupment charge has been $100,000.[110] Agusta pays the amount for each helicopter sold by Agusta to Boeing Vertol who in turn remits the payment to the local Army Plant Representative Office (APRO).[111]

Total Boeing Vertol income from the EMB-CH47C program breaks down as follows as of September 30, 1981:

Hardware sales	
Complete aircraft	$114,000,000
Parts	$148,100,571
	$262,100,571
License income	
Royalty	$ 15,012,037
Fees	$ 3,620,000
Services	$ 476,302
	$ 19,108,339

Comparable numbers for the other U.S. suppliers involved in the EMB-CH47C program are not available. Principle among these is the engine supplier, Avco-Lycoming, which has parallel license and purchasing agreements with Piaggio in Italy.

The U.S. Army's total R&D recoupment for the program came to $10,858,100 as of the end of 1981.[112]



Source: Boeing Italian Army EMB-CH47C

The first delivery of an aircraft from Boeing Vertol to Agusta was on April 20, 1971 (Boeing serial number D-001). This first contract involved the delivery of 10 CH-47s to Agusta. This included: 2 ship sets of detailed parts as 'prove out' sets (i.e. to check out tooling and assure it matched up with the hardware); 2 aircraft for delivery to the Italian Army; and 6 aircraft for delivery to the Imperial Iranian Forces. Boeing Vertol's D-001 aircraft was delivered to the Iranian Air Force on May 21, 1971 as Agusta's P-001. At the time Agusta stated that there were to be no more such buys of complete aircraft from Vertol.

a. The Licence Fee

The initial license fee charged to Agusta was $835,000 to cover Boeing Vertol costs during implementation of the agreement. This fee was to be paid off in eight payments between April 1968 and June 1973 but slid 10 months due to the elusiveness of Agusta's first sale.[113] These costs included the reproduction of technical data (drawings and documentation), its preparation for shipment to the licensee, a limited amount of technical assistance, plus the cost of administering the agreement. This fee only contributes marginally to the amortization of such non-recurring costs as research and development. The return on investment for the contractor comes primarily from the royalty paid on sales made by the licensee. The U.S. government, for its part, obtains a return on its investment through an R&D recoupment charge levied against each helicopter sold by the licensee.

Under competitive pressure, Agusta was successful in reducing the fee from that originally proposed by Vertol, $1,000,000. However, of the total licens-

ing fee of $835,000 agreed to in 1968 to cover the estimated cost to the licensor of implementing the agreement, actual expenses charged to Vertol's license fee escrow account during the first 10 year agreement only came to $625,000. As we will see shortly though, this excess fee above actual costs was offset by an unforeseen bonanza for Agusta in the area of royalties.

The original proposed fee had been geared to cover the estimated cost of all routine services to be provided by Vertol at no additional charge during the 10 year period concerned. Previous research by Vertol at the time of the negotiations for the KV-107 agreement with Kawasaki in the late 50's, had revealed that many licensee services had to be individually ordered, negotiated, invoiced, and so forth. This had proven to be a cumbersome process which irritated licensees and was costly to both parties.[114]

When the fee for the CH-47 was pressured to a level below the estimated cost, however Vertol reduced the list of services and data covered by the fee correspondingly. This revision involved the requirement for payment by Agusta on an item-by-item basis for certain follow-on services and data that had previously been offered at no additional charge. This ended up adding another $74,000 to the basic fee of $835,000 over the balance of the first ten year term, for a total fee of $909,000.[115]

Although the $74,000 represents considerably less than the original Boeing Vertol estimate, the subsequent charging of excluded technical support services on an item-by-item basis (after the transfer of the original technical data package), as had been expected, proved to be a nuisance. This data was

provided at cost (i.e. no profit), based on total pages for material and labor involved in reproduction and shipment preparation, with overhead also added in. For the first several years this involved two or three shipments a month, but later tapered off. Initially these costs were collected and the licensee was invoiced monthly, later quarterly, then bi-annually. Though provided at cost, Agusta complained that everytime they asked for something, Boeing Vertol had their hand out. Finally after enough cost history had developed it became possible to predict annual costs fairly accurately. As such, for the last 3 years of the agreement (1976-79), the two parties agreed to negotiate fixed price annual contracts. One year Boeing Vertol lost a little through this arrangement, though overall it was a wash. This allowed both parties to avoid excessive clerical work and petty negotiations. The practice of a fixed annual fee for technical support services was continued for the second term (1979-1994).

Another inadequacy that surfaced for Boeing Vertol in the area of the license fee involved the timing of fee payment. Payment must occur in a relatively compressed time-frame if cash flow is to stay in line with the heavy up-front expenses faced by the licensor.[116]

b. Royalties and Sales Territories

Whereas the fee is meant to cover primarily the licensors costs, royalties, in principle at least, correspond to profit or return on investment for the licensor. For setting the fee on completed aircraft, Boeing Vertol and Agusta adopted a fixed amount approach, as opposed to a percentage of the sales price approach. Though the licensor preferred a percentage royalty, the licensee

preferred fixed amounts. The licensor's position has prevailed for the EMB-CH47C, except for parts, which naturally required a percentage royalty.

Royalties on sales paid by Agusta during the initial 10 year agreement (February 10, 1969 to February 9, 1979) to compensate Boeing Vertol for the proprietary technical data and know-how provided, were based on the following formula:

	Exclusive Territory	Non-Exclusive Territory
Helicopters	$60,000	$75,000
Parts	5½%	8%

The $60,000 per aircraft built by Agusta roughly corresponded, at least in 1968, to the industry norm for royalty payments of between 5 and 5½% of the manufactured portion of the licensed product.[117]

All payments are in U.S. dollars. Royalty payments on spare parts have been a steady flow, while those on end aircraft have been more erratic, as one might expect.

Agusta's sales territory was divided as follows:

(1) An exclusive license to sell the EMB-CH47C in the Principal Territory, i.e., Italy, Austria, Switzerland, Greece, Turkey, Saudi Arabia, Kuwait, South Yemen, Bahrein, Qatar, Trucial States, Libya, Iran, and Morocco.[118]

(2) A nonexclusive license to sell the EMB-CH47C in the Additional Territory, i.e., Belgium, Denmark, the Netherlands, Norway, Spain, and Sweden (all Category A), plus Pakistan, Israel, Yugoslavia, Muscat and Oman, and Yemen as Category B countries. In March 1980, through amendments to the license agreement, Tanzania was added for a two year period, and in July 1980, Egypt was added for a nine month period.

(3) A nonexclusive license throughout the world to sell licensed parts for use with Chinooks sold by the licensee.

The principal problem area involving royalties stemmed from the agreement's having been originally negotiated during a period of minimal inflation for a fixed amount (as opposed to a percentage) with no need being foreseen for an escalation formula. As things turned out, however, with inflation picking up, the royalty was reduced in real terms by about half, i.e., to a 2 ½% royalty by 1978. This, too, was corrected by an escalation clause in the term extension agreement which took effect in early 1979.

The royalties paid to Boeing Vertol on sales by Agusta are adjusted to accommodate the percentage of Boeing Vertol content in the helicopters sold.[119] Consequently Vertol received no royalty on the 45 Chinooks sold Agusta between 1970 and 1978. As of 1975, the year in which the first helicopters came off the Italian production line, the royalty was $27,000, i.e. 55% Boeing Vertol content, with the percentage having been reduced to 37% by mid-1980.[120]



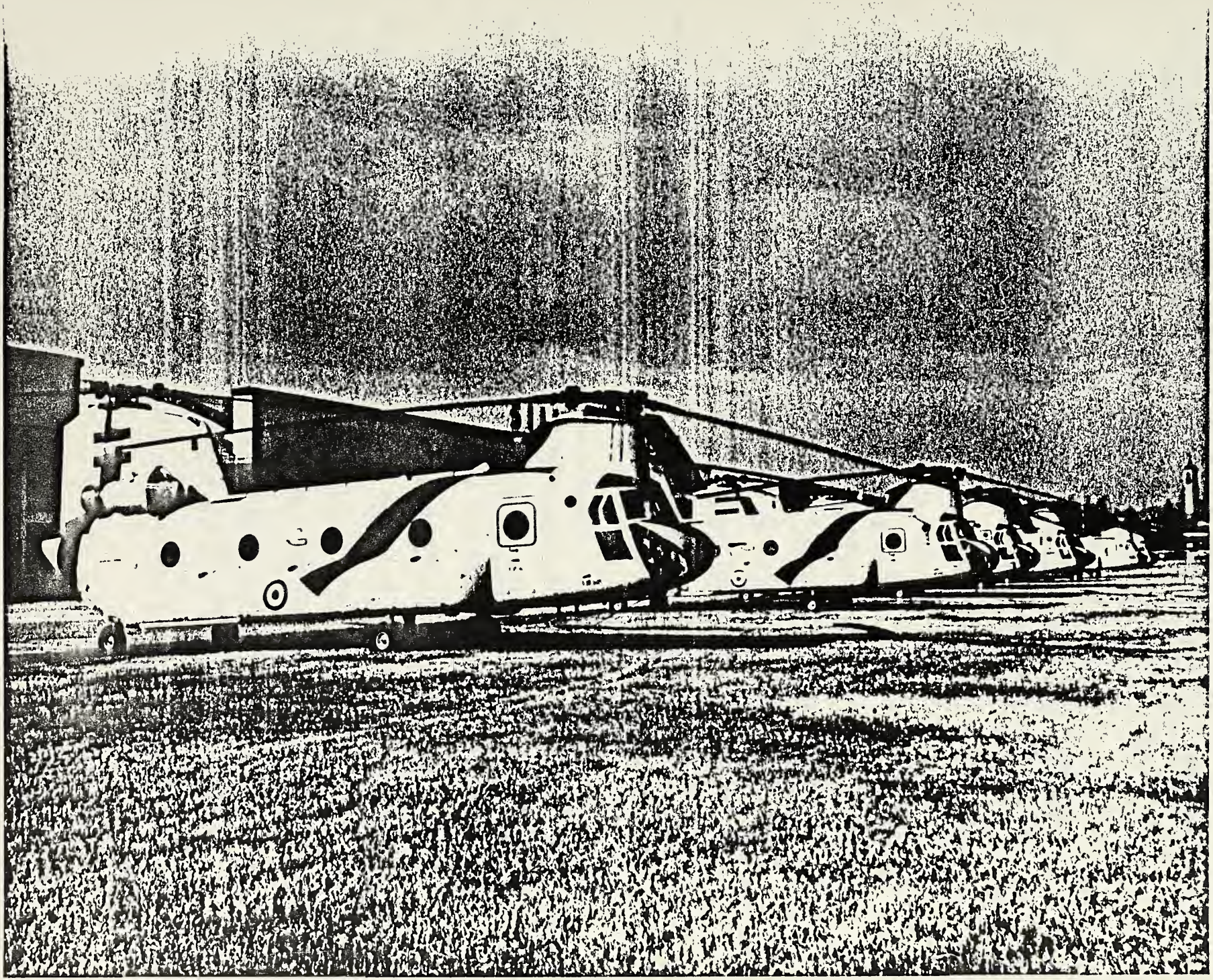
Source: Boeing Iranian EMB-CH47C

Under article 8.5 of the license agreement, Boeing Vertol has the right to an examination and audit of the licensee's accounting records by an authorized representative of Boeing (Touche Ross). All information so acquired must naturally be treated business confidential.

The primary point of contention that has developed over the last several years between the U.S. licensor and the Italian licensee in the area of sales has centered on Agusta's activities in countries not in either their exclusive, or their non-exclusive, territories (i.e. in the territory reserved by Boeing Vertol for itself).

Initially, this simply involved Boeing Vertol approval of their sales efforts in Tanzania after Vertol's own efforts had led nowhere. The Italians were later successful in landing a 2 aircraft order, and under Amendment #8 to the Licensing Agreement Tanzania was transferred to Agusta's sales territory for a 2 year period from April 1980 to April 1982.[121]

The second case was a bit more complicated and involved the sale of 15 Chinooks to Egypt. As a result of the U.S. embargo on Iran, Agusta was caught holding Chinooks that had been ordered by the Iranian Armed Forces, but which Agusta was not allowed to deliver. Consequently, the U.S. government proved to be receptive to Italian government overtures on behalf of Agusta, feeling obligated to help them dispose of the surplus helicopters. The U.S. government subsequently approved a switching, for the pending Egyptian sale, from Boeing Vertol Chinooks to Agusta Chinooks.[122] Following a Vertol Agusta agreement covering this sale the DoD not only waived its US Government R&D



Source: Boeing Egyptian Air Force EMB-CH47C

recoupment, but the DSAA pressured Vertol into reducing its royalty for the sale as well.[123]

The integrity of the originally delineated sales territories has more recently been further threatened by Agusta's marketing activities in Nigeria, Zaire and Indonesia.

Such territorial conflicts are not unusual in license production arrangements, and as we saw with the dispute between Northrop and the Canadian government over the F-5 sales to Venezuela, they can sometimes lead to protracted litigation. As with the possible U.S. Roland sales to Norway, however, room for compromise is usually found (see Chapter 9). In the case of the CH-47, the problem has a particular twist; the greater political acceptability of Italian arms salesmen in much of the third world.

When and if a sale actually ever takes place is sometimes an issue in license agreements. Agusta reports two times a year on aircraft and spares deliveries for royalty payment purposes, per the license agreement.[124] The bills come due 60 days following the end of each reporting period. Though ordinarily reporting for royalties is against deliveries, for the Tanzanian Chinook sale, due to the territory transfer, payment was to be up-front, upon signature of the contract. A contract was signed, but as Agusta rightly claimed, it turned out not to be a firm one. Consequently, Vertol has had an open invoice for the last 18 months as of February 1982.

Another ambiguous situation occurred in this regard with Vertol's KV-107 license. It involves KHI's company-owned demonstration aircraft (of which Agusta has none). The aircraft, the civil version of the KV-107, is utilized primarily as a test bed and to support sales efforts. One of Kawasaki's sister companies owns three KV-107's which are chartered for such jobs as power-line construction in the mountains. When one of the helicopters is temporarily down while under charter, KHI will periodically loan the sister firm its demonstration helicopter. In response to Boeing's royalty claim against the first such transfer, KHI took the position that because of the aircraft's minimal use in this role a royalty payment would be an excessive burden. In response, Boeing Vertol proposed a 5% share of all income generated from charter activities of the demonstration aircraft. KHI accepted the proposal and Vertol has since had a small income from this source as well.[125]

Then again the question arises, how should one treat a case where a demonstration helicopter crashes and is a total loss? In one sense no sale was ever consummated, but then, the licensee is compensated through insurance.

The above situations all involve transfers where the timing or even appropriateness of royalty payments are the issue. There are also cases involving the State Department's International Traffic in Arms Regulations (ITAR) where the timing of actual transfer becomes a bit fuzzy. Such a case arose with the Chinook and the embargo against Iran. Eight EMB-CH47C's had title transferred to the Iranians just prior to the Embargo in late 1979, but delivery of the actual aircraft did not occur until 1981, at which time the embargo was still in effect.

c. Intellectual Property Rights

As for patents and other proprietary rights, in Amendment #4 signed on January 1, 1971, Boeing granted to Agusta all those that it held covering components of the system. This locked up the manufacturing rights issue between the two firms, Agusta having decided it wanted the rights in their entirety for a full scale license production program.[126]

Vertol was under no obligation to grant to the licensee any patent or proprietary rights which are owned and/or controlled by third parties. And in fact, no third party rights or data were included.[127] Vertol did permit Agusta to deal directly, however, with certain North American subs and vendors upon written request.

In its efforts to reduce the U.S. content of the helicopters it manufactures, Agusta has had considerable difficulty acquiring the rights to those non-Boeing Vertol subsystems, none of which were included in the Boeing-Agusta license agreement. One of the major subsystems for which this was the case was the transmission produced by Litton Industries (formerly Foot Brothers). Typically this has involved either a flat refusal to sell the technology and rights, or simply offering totally unacceptable terms. In such circumstances Agusta must rely over the short run on purchasing from the U.S., while working to develop alternate sources over the long term.[128]

The licensee does not have the right to grant sublicenses unless the prior written consent of Boeing is obtained. However, the licensee maintains the

right to subcontract anywhere in Italy, Austria, or Switzerland without Boeing Vertol's approval, and to subcontract anywhere else in the world with the written approval of Boeing.

Under the terms of the agreement, if Agusta should release data without authorization to third parties, or fail to offer technical improvements to Vertol, then Agusta could be held in breach of the license terms and would be subject to arbitration in accordance with the Commercial Arbitration Rules of the American Arbitration Association.[129]

d. Organization

The Office of Manager Licensing and Export Controls is responsible for the EMB-CH47C program at Boeing Vertol. This office is currently held by the man who is also the source of most of the data in this sub-chapter, Ed Ritti. Other
activities falling under his preview include the KV-107 license production program in Japan, and technical assistance agreements with the Swedish government in support of their Navy and Air Forces's HKP-4's and with the Australian government in support of the RAAF CH-47C's.

The license agreements with the Swedish and Australian governments have both worked quite well. In Sweden the overhaul and modification work is performed in a government work shop. With Australia, on the other hand, though the license is also with the government, the work is contracted out to Hawker-deHavilland. The relationship is not a cumbersone one in that Vertol works

directly with Hawker-deHavilland except where contractual matters are involved. Australia buys spares and technical assistance from the U.S. Army and Boeing Vertol. Unlike with Sweden, Vertol doesn't have to obtain an OMC export license for Australia because delivery is made to Australia in the U.S., Australia's forwarder being the one that obtains the export license.[130]

The Office of the Manager for Licensing and Export Controls also handles the usual assortment of licenses with subcontractors that are now selling spares directly to the U.S. armed forces. In such mature programs as the CH-46 and CH-47 the prime contractor tends to gradually lose some of the spares business in those areas where the configuration has stabilized, as the customer goes directly to lower-tier suppliers. However, in those cases where prime contractor owned technical data and know-how are involved the spares business lost is partially offset by royalty income. These licensees do retain their role as subcontractors though, for all commercial direct sales of aircraft and spares to foreign customers, i.e. unless the foreign customer opts to go through FMS channels. Licenses with model airplane makers are also handled through this office.

The large majority of the purchase orders placed by the Agusta components with Boeing Vertol to support its production line are not handled by Ed Ritti's office, though he retains overall responsibility. Because of the volume and smaller value of most of the orders, they are bought through the Boeing Vertol organization that handles spares provisioning, the Product Support Group's Logistic Support Group. The offices of the Manager of Licenses and Commercial Contracts and later Licensing and Export Controls have dealt with the larger

orders for major sub-systems, for technical assistance contracts and the sale of completed aircraft. Otherwise the day-to day work of receipt and processing of purchase orders are handled by the spares organization within the Logistic Support Group, whether they go into the Italian production line or not, and are actually used for spares provisioning.[131]

Manning of the office has shifted over the last two decades from two managers, in the persons of Tony Tuccillo and Ed Ritti, three contract administrators and two secretaries in 1962, down to one manager, Ed Ritti, one contract administrator and part-time secretarial/clerical help in early 1982. Managing the Italian Chinook program ordinarily takes between 10 and 15% of Ed's time (except during 1970 and 1981 when technical data packages were being released). Originally the offices scope of responsibilities included all non-U.S. Government contract activity as reflected in Tony Tuccillo's title, Manager of Licenses and Com-mercial Contracts. However as foreign sales (direct as well as indirect through Agusta) became the mainstay of the Vertol division of Boeing during the 1970's, Commercial Contracts was set up as a separate office, and Ed Ritti took over as Manager Licensing and Export Controls.

The Costruzioni Aeronautiche Giovanni Agusta Societa per Axioni (S.p.A.)[132] subsidiary of Agusta S.p.A. is systems manager for EMB-CH47C program and is located in the village of Cascina Costa di Samarate outside the City of Gallarate some 60 kilometres south of Rome. Agusta S.p.A itself is located in Milano. In addition to being systems manager, Costruzioni Aeronautiche Giovani Agusta builds some of the electronics and such heavy machined parts as

are used in the transmission. Agusta's major Italian industrial partners for EMB-CH47C production include the following firms:

- The other three 100% Agusta owned subsidiaries:
  - SIAI Marchetti (located in Sesto Calende) - Fuselage, final assembly and flight test;[133]
  - Elicotteri Meridionali (located in Frosinone) - bonded assemblies, instrument console, aft ramp and drive shafts;
  - Industria Aeronautica Meridionale S.p.A. (formerly SACA, located in Brindisi) - flight control components.

-Suppliers:

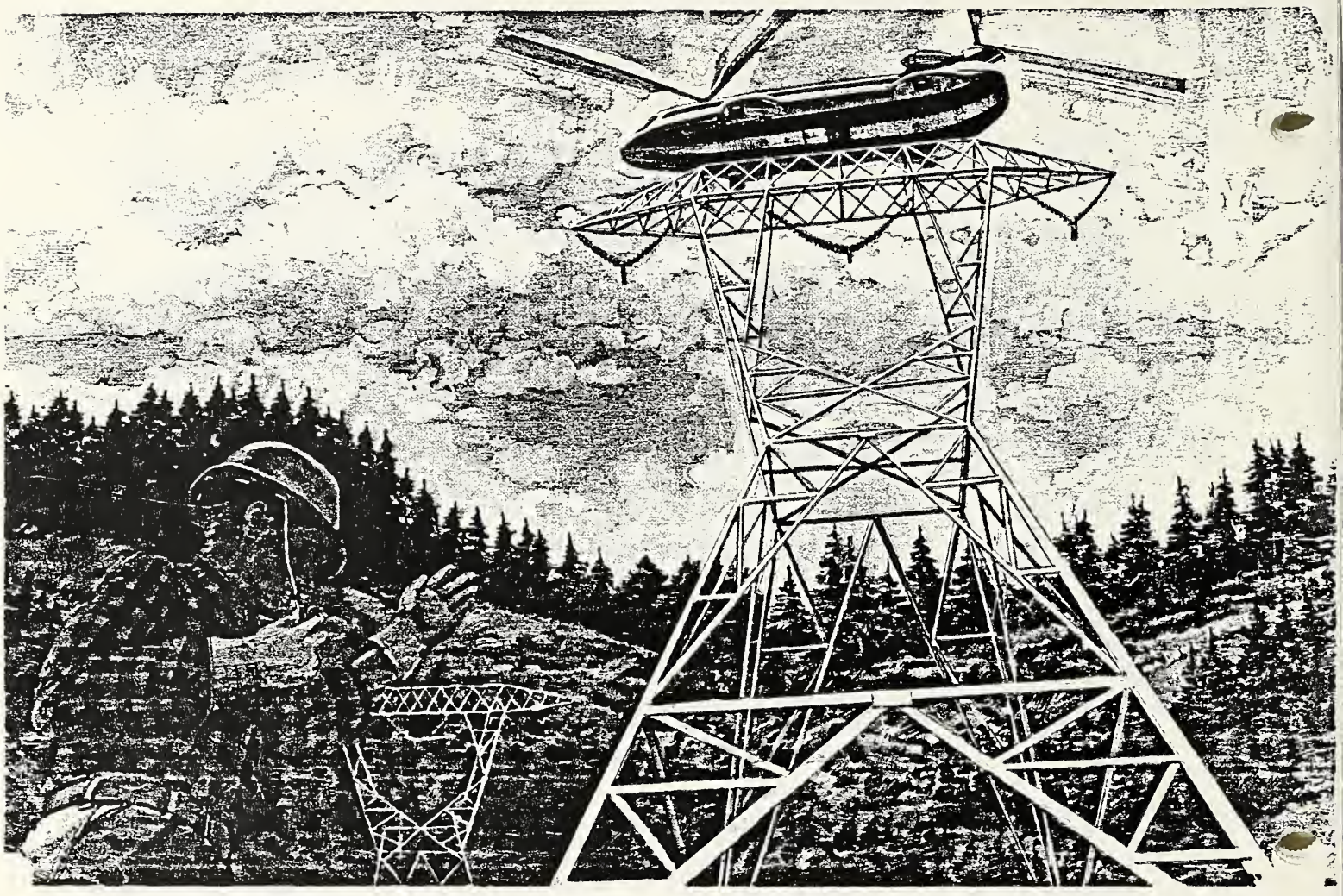
  - Rinaldo Piaggio - T-55 engines (which are produced under a separate license from Avco-Lycoming);
  - Magnahi - landing gear, blade damper and hydraulic actuators;
  - Logic - N1 control system for engines, and the power steering control box;
  - Pirelli - crashworthy fuel bladders, and;
  - Farem - fuel and oil system components.

Although the license was actually negotiated and signed with the Elicotteri Meridionali (E.M.) subsidiary of Agusta S.p.A. (hence the 'EM' in EMB-CH47C) shortly thereafter E.M. sent Vertol a letter contract for Vertol's countersignature delegating systems management responsibilities to the C.A.G. Agusta subsidiary of Agusta S.p.A. Consequently the working relationship becomes a bit confusing at times to the uninitiated. All contractual correspondence to Agusta is addressed to E.M. care of C.A.G. Agusta. Moreover, although all

technical data requests are steered through the C.A.G. Agusta focal point, orders and invoices come in from the four Agusta S.p.A. subsidiaries directly. Coordination of technical data dissemination requires Vertol to not infrequently refer data requests from the three other subsidiaries back to C.A.G. Agusta. For example, during visits to Vertol by personnel of the three subsidiaries, upon investigating data requests, Vertol often discovers that C.A.G. Agusta already has the data. Yet another twist to this relationship is that up until several years ago it was C.A.G. Agusta that contracted with the Italian government for its Chinooks, but it was E.M. that was responsible for all foreign contracts. As such Vertol would receive two separate royalty checks. Now all royalty payments come from C.A.G. Agusta.

In spite of this convaluted organization, the Agusta family has extensive experience with such programs. And, though coordination problems do surface, Ed Ritti is emphatic in characterizing Agusta's EMB-CH47C program as being a generally very well managed one.

Originally the Tony Tuccillo/Ed Ritti organization at Vertol had a counterpart focal point at C.A.G. Agusta that contributed greatly to the smooth management of the day-to-day flow of work between the two firms. Unfortunately though, in 1973, the C.A.G. Agusta focal point at the EMB-CH47C project management office, a Walloon/Italian named Jimmy Jackson, was transferred to Agusta International in Brussels and not replaced. For the following eight years Vertol found itself struggling with a multitude of focal points and a constantly changing set of actors. The working relationship with the licensor for the EMB-CH47C program was very loosely handled on C.A.G. Agusta's end. As



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a fallback, Tony and Ed had to often rely on C.A.G. Agusta's Philadelphia representative, who in turn had similar problems.[134]

This eight years of thrashing about for Boeing Vertol ended in late 1981 when a man with 30 years experience in the area was appointed as C.A.G. Agusta's Contracts and Licensing Manager (for all license production programs), Sergio Testa.

In the interim though, Vertol dealt directly with whomever at C.A.G. Agusta they needed to, with no focal point at C.A.G. Agusta. Tony and Ed had to rely on C.A.G. Agusta's resident representative in Philadelphia to tell them who they should get a hold of for a given issue. C.A.G. Agusta even tried on several occasions to open up direct channels between Vertol and the other Agusta subsidiaries (SIAI Marchetti, Industria Aeronautica Meridionale and Elicotteri Meridionali), but Vertol successfully resisted and forced the communications back through C.A.G. Agusta.[135]

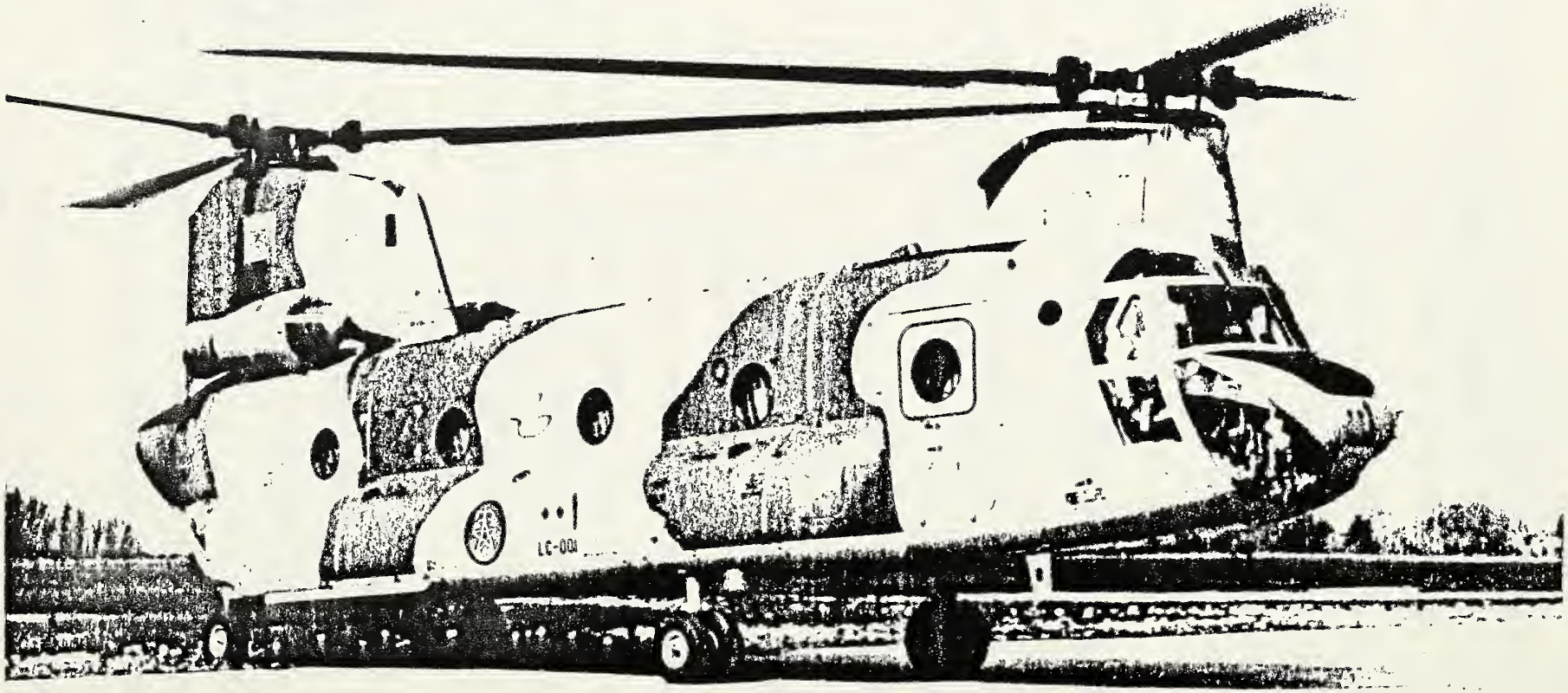
C.A.G. Agusta's representation in Philadelphia has usually been a one man show. Earlier in the program though, there had been one program management representative (with an engineering background) and one engineering rep. The C.A.G. Agusta representative has usually dealt directly with whatever Vertol functionals were concerned, but if something was needed in writing, then they went through contracts. The C.A.G. Agusta representative, currently Ing. Enrico Cecchini, has been involved in coordinating the following activities:

- Release of the original technical data package (TDP) for the CH-47C configuration in 1970 and later the release of the Model 414 TDP in 1981-82;
- procurement of parts for the Italian production line, as well as spares;
- technical questions from C.A.G. Agusta;
- processing C.A.G. Agusta MRB output through Boeing Vertol for review and approval.

Purchase order activity has generally involved most of the C.A.G. Agusta representative's time, except during the release of the original and Model 414 TDP's in 1970 and 1981.

Boeing Vertol's on-site representation in Italy is covered under sub-section g, "Technical Assistance and Technical Publications". Vertol never had an all purpose representative or team chief at C.A.G. Agusta, representation never exceeding three men at once. The first technical assistants were on-site in September 1970, with their being continued representation through May 1974. The only additional on-site technical assistance occurred in the summer of 1976.

In the area of communications, Ed emphasizes, a 'one-window' approach is required. Communications with the licensee and between each Boeing Vertol functional group (i.e., engineering, quality assurance, and manufacturing) and their on-site reps, must be channelled through one focal point. At Boeing Vertol this is contracts. Constant attention is required to counter the



Source: Boeing Moroccan Army EMB-CH47C

natural tendency of functionals to operate in a vacuum. This is especially important for those questions involving technical issues such as the interpretation of drawings and specs.[136]

The only exception to this involves the two companies product support managers. But then, even here there's a need to remind product support and contracts to keep one another informed.

In the carrying out of its export control responsibilities, Ed has at any one time between 12 and 15 active OMC export licenses open for the EMB-CH47C program.

e. Purchasing Arrangements between Licensor and Licensee

For those subsystems, parts, material and services procured in the U.S., Agusta originally had two channels through which to acquire them: either through its primary U.S. purchasing agent, Commerce Overseas Corporation (COC) of Elmsford, New York, or through Boeing Vertol, in Philadelphia. Under its Basic Ordering Agreement with Boeing Vertol signed in 1970, Agusta had purchased $262,100,571 in hardware as of September 30, 1981. Included in this sum were the 45 aircraft previously referred to (accounting for $114 million), as well as assorted surplus machinery, tooling, and parts, including five special catagories of parts produced by U.S. subcontractors and commercial vendors: specification control items; source control items; castings; forgings; and extrusions. Agusta also has the option to buy any of the above category of five items directly from the Boeing Vertol approved U.S. sources

shown on the Boeing Vertol drawings, with the exception of machined castings or forgings which must be bought through Vertol. In those cases involving direct purchase of Boeing Vertol spec or source control items, up until 1979, Agusta paid a 5% fee based on the acquisition price. This was dropped from the 1979-1994 agreement because it had become somewhat of sore point, along with the fact that the level of such direct procurement had been greatly reduced. Agusta had been developing its own sources in Italy, and as such it was becoming of less value to Boeing, not being worth the administrative costs.[137]

In addition to royalties, Vertol itself benefits in a somewhat less tangible, but still significant way from having a second source in that it has broadened Vertol's supplier base. In one case the previous U.S. supolier, Bendix, had dried up for a Boeing Vertol spec control item, the power steering control box. An Italian subcontractor of Agusta, however, Logic, located in Milan, had meanwhile developed an alternate system to Boeing Vertol specs. Vertol is now buying this item through Agusta.[138] In another case Vertol is now buying directly from Logic the engine condition control system actuator for the 234 commercial model of the Chinook (with Italy's equivalent of the FAA providing in-plant surveillance).[139]

Any foreground data developed as a result of the license agreement such as technical improvements incorporated by Agusta, are to be provided back to Vertol royalty and restriction-free. One example of this flow-back to Vertol of any technical improvements incorporated by Agusta, is the high power Nite-

Sun search light developed by Agusta for the Chinook. This optional feature has been adopted for the 33 Chinooks being bought by the UK from Vertol. Boeing Vertol buys the structural parts from Agusta and mounts them in the aircraft, while the British buy the lights themselves directly from Agusta.

In the words of Vertol's Manager of Licensing and Export Contracts, Ed Ritti, "One of the biggest problems involved in tapping such alternate sources is getting the U.S. engineers to accept them. Although I feel we don't use these sources enough, the engineers' attitude is often one of 'I don't care what they put on their helicopters, but don't put them on ours."[140]

This interdependence between Vertol and Agusta with regards to suppliers, occasionally calls for cooperation in another area as well. Boeing Vertol Materiel and Agusta's U.S. purchasing agent, at one point, had to work out a joint agreement for simultaneous ordering, i.e. rationing, in the face of a transmission casting shortage, caused by the loss of one of the forging and casting plants, which had been forced to close down by OSHA requirements. This allowed them to share the impact of a bottleneck by combining requirements and juggling deliveries more effectively during the time it took to requalify a vendor, while avoiding the risk in the interim of falling into the role of antagonists competing for limited supplies.[141]

In addition to handling shortages, the two firms have been able to work closely together in disposing of surplus items, one of the major pay-offs of license production programs. One case arising in mid-1981 involved a Boeing

Vertol surplus resulting from their phasing out of metal rotor blades. Boeing Vertol made a list of all the resultant surplus parts, and sent it to Agusta (who was still producing the metal blades), with offers of significant price breaks. In this case Agusta made purchases totaling several hundred thousand dollars. Moreover, among these purchases there happened to be one critically needed item, the requirement for which had fallen through the crack at Agusta purchasing.[142]

This particular surplus items package also provided a recent example of a significant area of activity between Boeing Vertol and Agusta which has saved both parties, along with the U.S. Government, millions of dollars; disposal of surplus machinery. This case involved a surplus root shot peen machine (used in surface hardening for metals). Instead of Boeing Vertol's having to sell it on the used tool market or for scrap for practically nothing, they were able to get $18,000 from Agusta, who itself benefited by not having to pay the ¼ million dollars that would have been required to buy a new one. Agusta also benefited from a shorter lead-time and a remaining service life that was more in line with their projected needs. Agusta contracted separately with the original manufacturer, Wheelabrater, who sent in a technician to supervise the dismanteling of the machine, transported it back to its factory where it was inspected, refurbished and shipped on to Agusta with a new warranty.[143]

There have been numerous such cases of surplus contractor and government owned machinery and tooling being bought up by Agusta to the benefit of all parties concerned. Another case involving precision masters for the rotor blades and gears is mentioned in the next sub-section on the Transfer of the Technical

Data Package. Worthy of note, however is the very different experience Boeing Vertol had with Kawasaki on the KV-107 license production program in this regards. Kawasaki always took the position that the worth of such machinery and tooling was next to nil since Boeing Vertol's alternative was usually only scrap. So in contrast to the EMB-CH47C program, there was very little commerce in this area for the KV-107 program, to the loss of all parties concerned.[144]

The opportunity of being able to dispose of surplus hardware and machinery in this manner to everyones mutual benefit depends on whether one is gearing up production while the others production is tapering off, or on whether or not the configuration of the system produced by the licensee is lagging somewhat behind that of the licensor. The existence of such a lag is more often than not the case, and is one of the reasons licensors can feel comfortable with selling the technology and rights. Another factor bearing on the feasibility of such a relationship ever existing or not is whether the licensee is starting from a lower capital/labor ratio base and therefore would be able to utilize the machinery. Neither of these situations tend to prevail however, when the U.S. military is the customer and a U.S. firm is the licensee.

More generally both firms are periodically called upon by each other to juggle assets so as to help the other cover a shortage. However, as Agusta geared its production up on an incremental basis, it only gradually increased the element of the system that was Italian manufactured from an original percentage of 45% in 1975 to 63% in 1980. Having time to fully digest the technology and know-how transferred, it never found itself having to rely heavily on bail out by the licensor during the early phase of the production run. Biting off the whole system at one time as the U.S. Roland program attempted to do, requires a perfect planning job, which is too much to expect of any industrial venture as complicated as a helicopter or SAM system.[145]

The use by Agusta of their prior procurement agency, Commerce Overseas Corporation (COC) is being phased out now that Agusta has set up a U.S. subsidiary in Houston, Texas, the Agusta Aviation Corporation. Established in early 1981, the Houston based outfit will handle U.S. buying for all U.S. helicopters built under license by Agusta (i.e., Vertol, Bell, and Sikorsky designs) as well as marketing and servicing its own Agusta designed helicopters, the A-109 and A-129.[146] With the Texas subsidiary Agusta will be able to much more rapidly and fully exercise direct buying rights in the U.S. This effort to go direct to U.S. suppliers has been complicated in part though by territorial conflicts involving some of the U.S. vendors' International and European distributors.

The Texas subsidiary is also picking up some of the balance of the U.S. procurement activity still remaining at Boeing Vertol. Contributing to the decision to set up an organic U.S. purchasing capability, Agusta had been fighting

for years to break free of the U.S. licensors control over certain areas of procurement because of the sizeable mark-ups, or loadings, that they involved (be they DCAS approved factors and rates for pricing by the invididual firm). For its part, Boeing Vertol had repeatedly pointed out that when going direct on spec and source control items, a licensee loses the benefit of the licensor's configura-tion management services. Boeing Vertol cited a case that arose during its older KV-107 program wherein Kawasaki opted to go direct to a U.S. vendor for the engine condition control actuator. The vendor had meanwhile changed the design, having gone to a welded joint. Boeing Vertol, however, felt very strongly that, as a result of this design change vibration problems could become dangerous. Luckily, the 12 actuators were caught in a Kawasaki warehouse once Boeing Vertol had become aware of the purchase, and the parts were sent back to the U.S. vendor, where they had to be reworked.[147]

For the EMB-CH47C, Agusta principal U.S. suppliers are currently:

Boeing Vertol;
Avco Lycoming
Solar
Honeywell (Minneapolis), and;
various casting and forging houses.

Agusta and the Italian Army have not purchased anything for the EMB-CH47C through the U.S. government FMS channels. The only case of Agusta relying on

the Italian government for procurement is the Avco-Lycoming engine, and this was only for the Italian Army's Chinooks.

Subsystems that are currently targeted by Agusta for repatriation, i.e. bringing the Lira back home through developing Italian sources for previously purchased items, include:

- additional hydraulic components;
- additional Italian source development for specification/source control items, and;
- with the signing of Amendment #9 to the licensing agreement in March 1981, fiber glass rotor blades.

f. Transfer and Control of the Technical Data Package (TDP)

Boeing Vertol obtained the first of its annual licenses from the U.S. State Department on February 10, 1969. This license provided clearance for the export of technical data and hardware, under the approved license agreement. Boeing Vertol was to have commenced delivery of data upon receipt of the second initial license fee payment ($168,750) on March 9, 1969, per the license agreement, however, this date was revised, sliding to January 28, 1970. The first data shipment left Boeing Vertol on February 4, 1970 with the "Initial Technical Data" being established as complete on December 31, 1970.

Vertol shipped to Agusta (FOB Philadelphia) a complete set of Boeing owned data; including engineering, manufacturing and quality control data, along with sundry know-how.

The original TDP provided by Boeing Vertol to Agusta included as the following:

(1) Engineering Data

a. Standard Repair Manual
b. Materials and Process Manual
c. Detail Specifications
d. Flight Test Acceptance Procedures
e. Design Drawings
   All Dimensioned Drawings
   Non-Dimensioned Grid Drawings
f. Functional Test Procedures
g. Standards Manual
h. Engineering Manual
i. Process Manual
j. Data List
k. Manufacturing Specifications
l. Procurement Specifications
m. Technical Reports
n. Acceptance Test Procedures
o. Subcontractor's Design Specifications
   and Standards
p. Engineering Quality Requirements
q. Interchangeability Report

r. Structural Integrity Report

s. Weight Report

(2) Manufacturing Operations Data

a. Quality Control Manual

b. Operation and Inspection Records

c. Quality Control Forms

d. Tooling Manual and Code

e. Tool Design Drawings

f. Assembly Parts List

g. Manufacturing Plans

h. Wire Group Orders

i. Parts Cards

j. Bulk List of Material

k. Tool and Production Planning Manual

l. Non-design Tool Information

m. Tube Band Data Cards

n. Certification Documents Manual TM-101

(3) Miscellaneous Data

a. Overhaul Tool and Equipment List

b. Overhaul Tool Drawings

c. Customer Service Bulletins

d. Customer Service Notes

Translation of data into Italian was left to Agusta, and all measurements were converted to metric by computer at Agusta. Agusta's drawings are both bi-dimensional and bi-lingual. In the conversion to metric, Agusta adopted tighter tolerances than Boeing Vertol, the machining of parts thereby being more precise in Italy, and thus helping to assure interchangeability.

EMB-CH47C techical data can be transferred by Agusta only to subcontractors in the three Category A countries that fall within Agusta's Exclusive License Territory. For third countries, the transfer of data was restricted to that sufficient for operation and maintenance of the EMB-CH47C, i.e. standard tech manuals. Any exceptions to the above would require both Boeing Vertol and OMC approval. There have been none to date.

Boeing Vertol agreed to facilitate the supply of any third party data on a 'best effort' basis only. Moreover this data was to be provided subject to any restrictions and/or demands for compensation placed on it by the owner.

One of the main problems encountered that concerned the transfer of the TDP arose in those cases where a supplier manufactures an item to Boeing Vertol owned drawings, but the item is one which Boeing Vertol has never itself produced. In such cases Boeing Vertol could not provide the manufacturing process data, tool design data, and related know-how. This could only be obtained from the third party. As with other areas of intellectual property rights, the suppliers reactions to Agusta's requests covered the full range from 'sure, we'll run you off copies if you pay the reproduction costs', to

'we'll be glad to license you for a certain price' (from nominal to proposterously large sums), to 'the only way you'll get it is if you buy the firm.[148]

Agusta's not inconsiderable experience in license production led the Italian firm to adpot an approach to tooling that allowed it to both rapidly reduce its dependence on the U.S. licensor and save money, while simultaneously helping to maintain strict international interchangeability of subsystems and components. Agusta bought only a limited amount of master tooling from the U.S. choosing instead to build their own tooling from copies of updated drawings[149] provided by Boeing and to fit the tooling to assemblies and parts just out of the U.S. jigs. The two knocked down helicopters bought from Boeing Vertol were used as 'prove out' or 'erector' sets.

Those exceptions where Agusta opted to buy tooling from Boeing Vertol involved precision masters in such critical areas as rotor blades and gears[150]. The procurement of these masters was greatly facilitated by the timing of the program's startup.

In these cases surplus masters had recently become available where Vertol had cut back from two sources to one as part of the wind-down from the Viet Nam war. Not only was Boeing Vertol able to buy up masters cheaply but they also cushioned the U.S. Army from the drop in volume. Boeing Vertol was able to buy for Agusta masters declared surplus by the Army, as well as save the Army from termination charges on masters for which they had yet to take delivery (e.g. 12 master gears).[151]

Ed Ritti pointed out paranthetically that not all license production programs are able to benefit from such timing. If there had been several foreign sources this couldn't have been done. Citing the F-104 Starfighter program as an example of one where there are multiple foreign sources (both within the NATO-Europe program, as well as there being two other license programs, one in Canada and one in Japan), Lockheed found itself unable to distribute surplus master tooling. How could they provide it to the Italians and not the Dutch? This dilemma further contributed to the problems the NATO F-104G program experienced in maintaining adequate interchangeability of hardware coming off the multiple production lines.

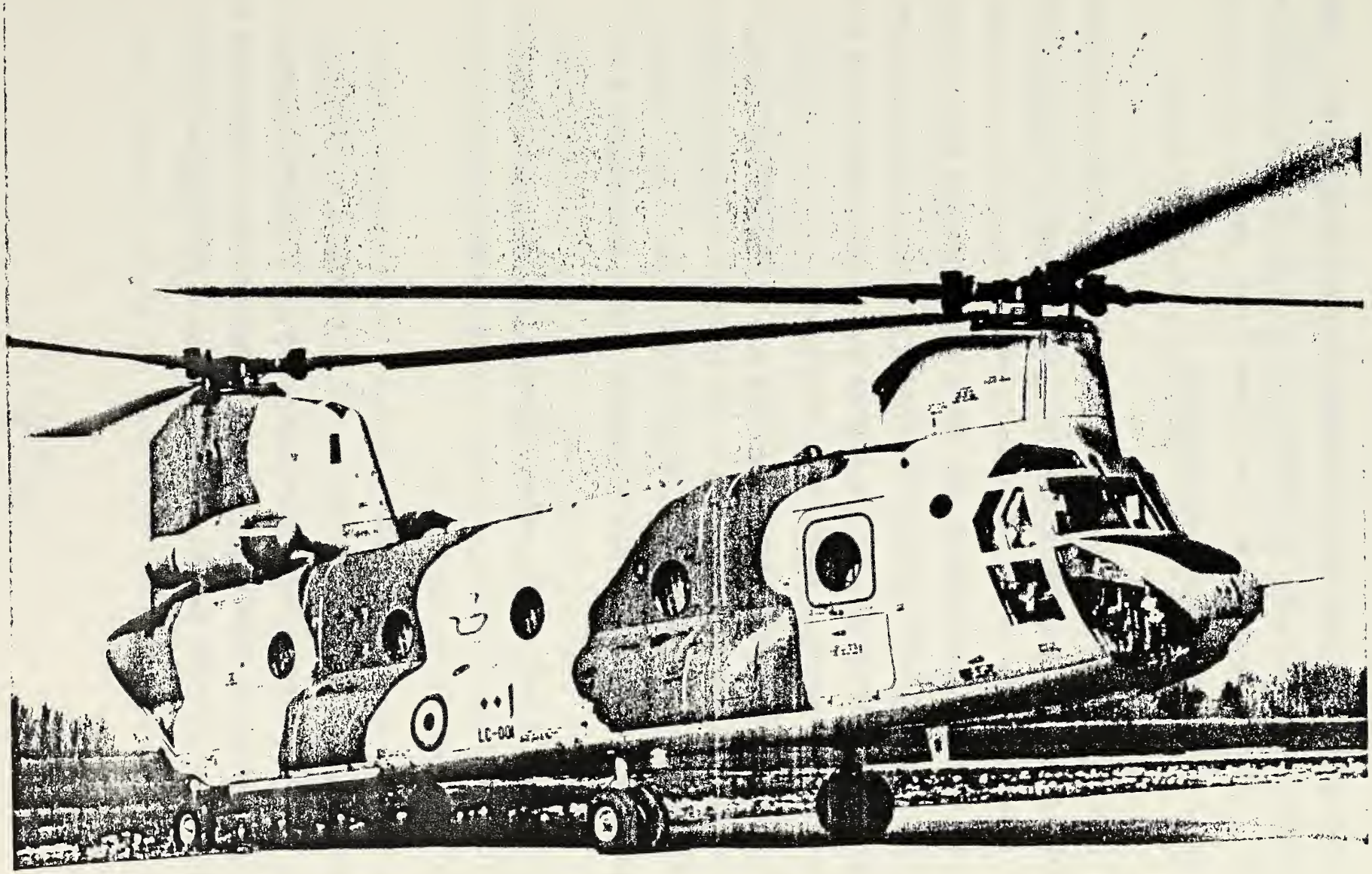
Another lesson learned from the Kawasaki effort that was applied to the EMB-CH47C program concerned the usual need for constant vigilance to assure the thorough recording of technical data shipments and the importance of channeling all communications between the licensor and licensee through a common focal point.

There is a need for both the licensor and licensee to keep good records of all technical data shipments and communications, tracking inquiries coming in, answers going out, and issues that are still open. Though these points apply in the management of all second source efforts, be they a subcontractor or a licensee, this is particularly critical for programs in which the industries of two or more nations are involved; where differing modus operandi and attitudes, greater distance and time zone differences, and the language barrier further complicate an already difficult task.[152]

In the area of the transfer of technical data, the Engineering Data Control Center has been able to easily expand its usual activities of controlling the dissemination of data (either internally, or to and from the government and suppliers) to include the needs of the EMB-CH47C license production program. It was a little less smooth for manufacturing. They originally, had a man devoted full-time to support the Agusta program, but as the level of effort decreased during the early 70's, this could no be longer justified. Since this time that minor problems have cropped up. Even though no great cost is involved, Boeing Vertol not too infrequently finds itself having to make belated and/or duplicate shipments of data.[153]

One critical area of activity that absorbs considerable effort is simply maintaining the accuracy of the data transmitted. Accuracy of data is a major problem in any complex second source effort, be it license production or sub-contracting. The licensor can only endeavor to minimize the problem while agreeing to correct any discrepancies once brought to its attention. A licensor must be ready to react quickly to rectify the situation, providing correct data immediately so the effort can go forward, picking it up later on the next drawing revision.

As is the norm, the license agreement requires that the licensee's product conforms to licensor's technical data package, all deviations being subject to Boeing Vertol approval. The license agreement differentiates between major and minor design changes. A major change is one that could affect the air-worthiness of the vehicle. Any such changes must be reviewed and approved by Vertol prior to being incorporated in the system. However there is the stipu-



Source: Boeing Libyan Air Force EMB-CH47C

lation that Boeing Vertol must disapprove the change within 60 days, otherwise Agusta can go ahead. For minor design changes, i.e. those which don't impact air worthiness, Agusta can make the changes without approval, but must periodically update Vertol on all such activity.

In good part, due to the lack of one person at the Agusta PMO as the responsible manager for the license, a number of major changes have gone unreported for some time prior to their discovery by Vertol. Agusta engineering was often operating in a vacuum in this regard and changes were never relayed to Vertol. One such change was the aforementioned Nite-Sun search light which was in use on operational Iranian Chinooks when Vertol discovered the change. Another case involved a number of source and spec controlled items wherein Agusta had made 'major' changes, but Vertol only discovered them after their incorporation into aircraft during a visit to Agusta. Vertol did approve them after the fact, providing Vertol QSR approval for all of this batch, but requiring that prefix on the name plates be changed from a 114 to a 219.[154]

Agusta must naturally also comply with changes spelled out in the service bulletins issued periodically by Vertol's product support group to all customer's, as well as the licensee.[155]

The two firms also collaborate in the area of the review and approval of deviations during manufacturing at Agusta. In the first several years of the license production program there was considerable Material Review Board (MRB) activity at Vertol in support of Agusta, for cases where the latter felt it

lacked the experience to make a decision. Once Agusta had been manufacturing for several years though, this MRB activity at Vertol became only sporadic.

g. Technical Assistance and Technical Publications

Technical assistance was provided by Boeing Vertol so as to assure that the licensee and its suppliers became and remained qualified manufacturers.

As previously mentioned, one set of technical data used by, owned by, and in the possession of Boeing, and which was to be used by the licensee for the manufacture, sale and service of licensed products, was furnished. Commercial catalogues and brochures, as well as U.S. Government specifications, tech manuals, and regulations were excluded from the data supplied by Boeing. These exclusions are a direct result of Boeing Vertol's experience with the Kawasaki KV-107 helicopter program where the provision of such services became an unexpectedly large effort in cost and time. Though this does not prevent Boeing Vertol from occasionally providing such services, ordinarily, Agusta will make its own arrangements, more often than not going direct to those same services utilized by Vertol.

For the purchase of copies of U.S. Army tech manuals, however, after encountering considerable problems, Agusta opted to have Vertol acquire these publications under a separate contract which included payment for all costs and freight. This Publications Acquisition and Distribution Management Contract is negotiated and renewed on an annual basis.[156] This is currently the only instance of case-by-case charging for technical services.[157]

In the area of technical assistance, support to be provided to Agusta, and covered by the $835,000 license fee, was spelled out in the license agreement as follows:

(1) Clarifications and explanations of technical data would be provided at Boeing plant at no additional charge;
(2) During the first 2 years, starting in January, 1970, Boeing was to furnish the necessary facilities for not more than three resident licensee representatives;
(3) During the first 2 years beginning in January, 1970, Boeing would provide courses of classroom instruction at the Boeing plant in English, without additional charge. Any courses after the initial 2 years would have to be paid for by licensee.
(4) Boeing personnel requested by licensee would be furnished to consult with and advise the licensee concerning the manufacture and service of the Licensed Product, subject to payment of Boeing costs.
(5) During the first eighteen months starting from January 28, 1970, Boeing agreed to furnish one technical representative for a total of 12 months at its own expense.
(6) Within the first 30 months starting from January 28, 1970 Boeing would provide a pilot for one thirty day period at its own expense.

To summarize the above framework for the provision of technical assistance to be provided by the licensor, Boeing Vertol committed itself to provide at its own plant: classroom instruction (January 1970 - January 1972); clarifications of technical data (over the full 10 year term of the license); plus

facilities for up to three resident licensee reps (January 1970 - January 1972). Boeing also committed itself under the license agreement to provide to the licensee at its own plant: one technical rep (for 12 months between January 1970 - July 1971); and one pilot (for one month sometime between January 1970 and July 1972).

All of the above services were also to be provided at no additional charge as they were covered by the $835,000 license fee paid by Agusta to Boeing Vertol. The third, as well as largest, component of technical assistance to be provided at the licensee's plant, however, involved only a commitment by Boeing Vertol to provide technical personnel as needed under separate additional contracts.

Follow-on technical assistance contracted for by Agusta and to be provided in Italy, as it geared-up for production included:

- One manufacturing planner for 2 years (September 1970 to September 1972);
- One industrial engineer for 2 years (September 1970 to September 1972);[158]
- One blade technician for 1 3/4 years (July 1972 through March 1974);
- A flight test engineer and pilot for two one month periods in July and August 1972.
- An engineer for test equipment set up, for two one month periods (May 1972 and June 1973);
- One test engineer for load-run qualification of transmissions for a six month period (November 1973 through May, 1974);

- A one month instructors course for air frame maintenance in August 1976 and a course for transmission (power train) maintenance in July 1976;

There were only two cases wherein the technical assistance contracted for by Agusta was provided in Philadelphia. The two cases of technical assistance provided under contract included:

- one 19 man OJT program extending over several weeks[159];
- a drive system course for three Italian instructors during a three week period in mid-1976.[160]

All other cases of OJT in Philadelphia were on an occasional basis involving one to several men as time, and were chargeable to the license fee escrow account. Though varying in duration from several days to several weeks these visits tended to average about one week.

Contrary to a practice seen in many other programs, Boeing Vertol bucked the norm in the area of pricing for such technical assistance. Though this is usually a very lucrative area of activity for licensors, Boeing Vertol provided technical assistance with only minimal profit added.

Boeing Vertol was so scrupulous in its providing personnel at little more than cost that their was only a limited contingency fund for unknowns such as cases wherein emergency home leave was required or it was necessary to slightly extend a stay.

As things turned out there was never any formal classroom instruction carried out in Philadelphia which was covered by the license fee. It was cheaper and more efficient for Agusta to have such instruction carried out at its plant in Cascina Costa. It was logically more cost effective to fly several instructors across the Atlantic and maintain them in Italy where there was a wider exposure than to fly classrooms of pupils over to the U.S. for the duration of instruction. In lieu of this classroom instruction priced for in the license fee, both parties agreed that the assigning of a Boeing Vertol flight test engineer in July of 1972 would be at no charge to Agusta. However, in those cases where Boeing Vertol had training program hardware available for its own purposes there was some ad hoc training that took place in Philadelphia. Also, for OJT early-on in the program, this naturally had to be on the licensor's existing production line, but in order to minimize disruption of manufacturing at Boeing, this had to be hands off OJT.[161] This had to be contracted for under separate technical assistance contracts as it was outside of the scope of the license fee, as was the vast majority of the technical assistance provided Agusta, it being hard to estimate with any degree of accuracy the package that would eventually be required.[162]

Downstream, as the licensee's manufacturing line begins to gear up, OJT can shift over to the licensee's own facilities. Here OJT generally works better as it can actually be 'hands on'.

Occasional visits of Agusta technical personnel to Philadelphia for explanations and clarifications are covered under the license fee (the $835K for the first term and the annual $80,000 and $40,000 payments for the second term).

Such technical support is generally part-time, costs the licensor very little, and is not all that disruptive.

Since Boeing Vertol obviously can't maintain people in each technical area that can speak the numerous languages required to provide technical support to licensees and foreign customers, they must rely heavily on technical translators. This, however, calls for a considerable slowing down of all instruction as everything must be repeated several times. In one particular area though, pilot training, there is no time for translation, and either the instructor or the trainee must speak the others language fluently. With the widely vary-ing English language capabilities that one would expect from among the large number of licensee personnel exposed to instruction, English can be relied upon for certain individuals when on a one-to-one basis or for certain small groupings. But for the majority, translators will be required. Even when the licensee can assure the licensor that a given group is sufficiently bi-lingual to not require translators, this must be viewed with a critical eye. In the one case where Agusta contracted for OJT (hands off) in Philadelphia for 19 men in various technical areas, Boeing Vertol priced for translators in its proposal, but Agusta was adamant in saying they didn't need translators for this team and wouldn't pay for it as they were all proficient in English. Upon arrival at Boeing Vertol however, there were immediate problems. Translators had to be obtained and brought in before the training could go forward. Since then the practice has been to quote for translators and leave it open for those cases where it is found to be necessary.[163]

Another area requiring attention when involved in the OJT type of technical assistance is photography. Inevitably when Agusta people are sent over to Philadelphia for training, they want to take pictures of the manufacturing process. As there are strict security regulations about visitors and cameras in defense plants, Boeing Vertol could only get approval from the defense security agency for the foreigners having cameras on them in the plant, if they were accompanied by a Boeing employee all day long in surveillance. This naturally being too expensive a proposition, Boeing Vertol usually just designated one of its own people in each work area concerned to keep a camera available and take pictures as needed. Only in those cases where high quality and/or a large amount of photographing is required, are Boeing Photo Lab people brought in.

h. Work Authorization Plan

The Work Authorization Plan for implementation of Boeing's task and obligations under the license agreement over its ten-year term was divided up as follows:

(1) Delivery of initial technical data to licensee;

(2) Delivery of revision and additional data to licensee;

(3) Boeing "in-house" technical assistance;

(4) Orientation of licensee personnel at Boeing;

(5) Formal maintenance training at Boeing;

(6) Boeing technical team services in Italy;

(7) Boeing technician in Italy;

(8) Boeing instructor pilot services;

(9) Boeing special technical services;

(10) Accounting charge numbers;

(11) Technical data exhibits.

Licensee purchases of materials, parts and services were covered by a separate Purchasing Agreement (the Basic Ordering Agreement) and a separate Work Authorization Plan.

i. Amendment #7 for (The Second Term, 1979-1994) and Amendment #9 for Model 414

Under Amendment #7 to the License Agreement, Agusta obtained the right to continue producing the Chinook after the original 10 year term had expired. The second term for the EMB-CH47C license covers the 15 year period extending from February 10, 1979 to February 9, 1994. For this period the royalty agreement was increased as follows:

	Exclusive Territory	Non-Exclusive Territory
Helicopters	$225,000	$281,250
Parts	6½%	8%

Unlike the previous agreement the new royalty rates include an escalation formula, one pegged to the U.S. Bureau of Labor Statistics' Producers Price Index (PPI) for Industrial Commodities.[164]. Therefore the royalty assessed against each sale remains constant in real terms throughout the life of the agreement.[165]

Continuing a practice adopted in the out years of the first 10-year term, the two parties agreed for the second term to a fixed annual fee for the provision by Boeing Vertol of follow-on technical support services (e.g.drawing revisions and explanations). The license fee for this second term was $80,000 per year for the first four years starting with February 10, 1979, and $40,000 per year thereafter for the last eleven. Starting with the third ($80,000) payment the fee has been subject to escalation per the above PPI. This actually came to $85,400 for third payment. For this second term, heavier front loading of the fee was not required due to the technical support costs being simply on-going revision services. Though this greatly reduced the bothersome item-by-item billing there are still some technical support services that are outside this agreement, and therefore would still be charged for.[166]

Two years later on March 6, 1981, Amendment #9 to the license agreement, under which Agusta obtains right to manufacture the Model 414 of the Chinook and composite blades, became effective upon receipt of the U.S. State Department's Office of Munitions Control (OMC) approval. Thirty days following this approval of the amendment by the OMC, Agusta was obligated to make the first of four annual payments of $875,000 each for the rights and technology of Boeing-Vertol's Model 414 and the fiberglass rotor blades. The total of $3.5 million that Agusta has agreed to pay includes, in good part, compensation for the high IR&D content of the composite rotor blades. The transfer of the TDP began in March 1981 and was not quite totally released as of March, 1982.

5. Lessons Learned

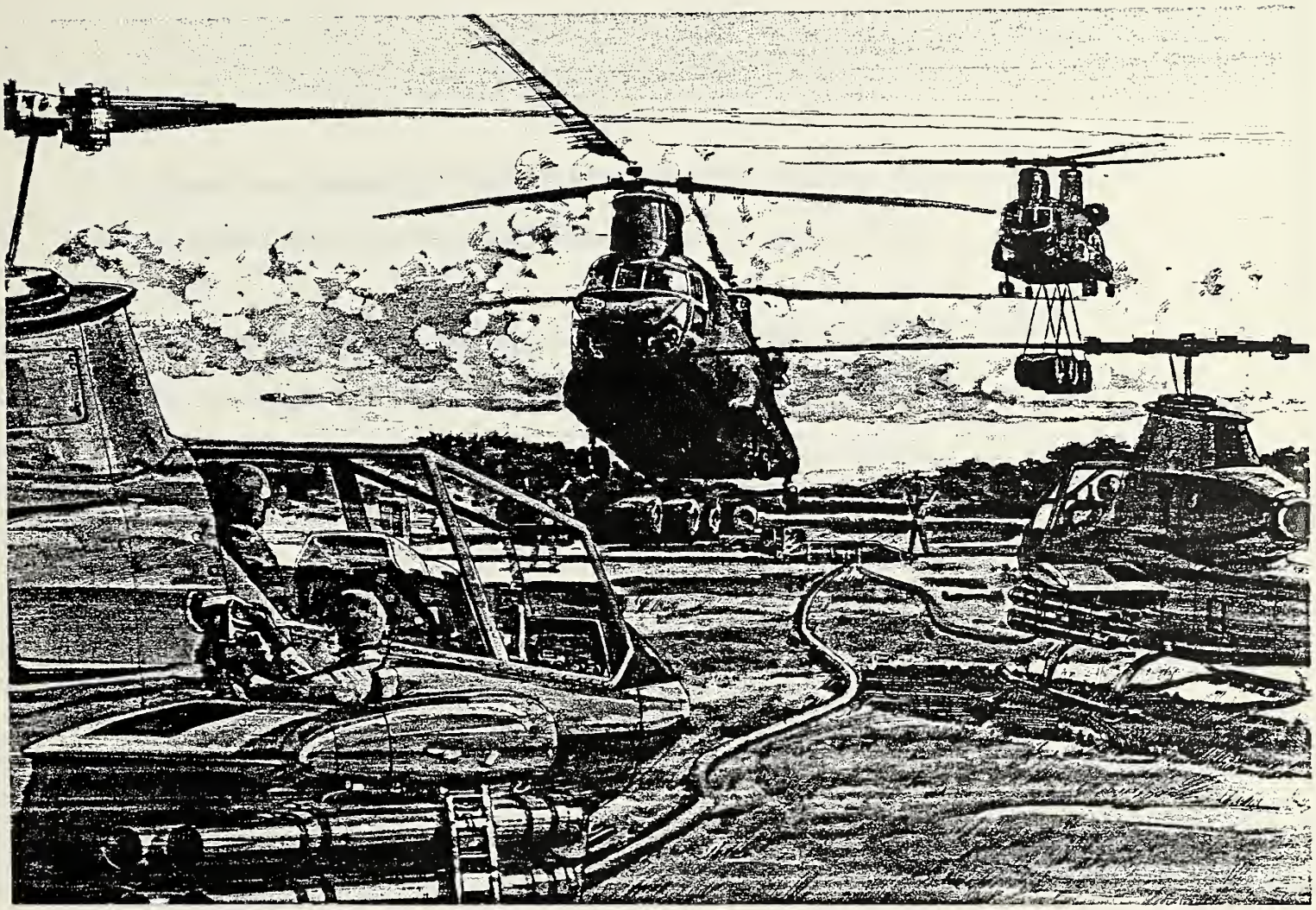
The following summary of some of the problems solved, and new concepts that had to be developed, was offered in an April 1976 White Paper, by Ed Ritti's predecessor, Anthony Tuccillo, then Manager of Licenses and Commercial Contracts, at The Boeing Vertol Company.

(a) Our Japanese program taught us of the great risks involved when initiating co-production close to the start of our domestic production, i.e. during a period when the configuration of a system continues to be fluid. Fortunately, for the Agusta program this was not an issue.

(b) We learned early of the need for an airtight system which forced all communications into central control points at each party's organizations. The making of unauthorized commitments was enough of a problem, but unreported commitments were even worse.

(c) The difficulty and cost of obtaining and transferring manufacturing know-how and rights for parts of our own design which had been subcontracted by us to third parties for development, test and production, were considerable headaches.

(d) There is a need to be able to transfer efficiently and quickly massive amounts of technical data and know-how at program initiation and to do so with a high degree of accuracy, completeness and continuity, and then to continue with the new and updated data.



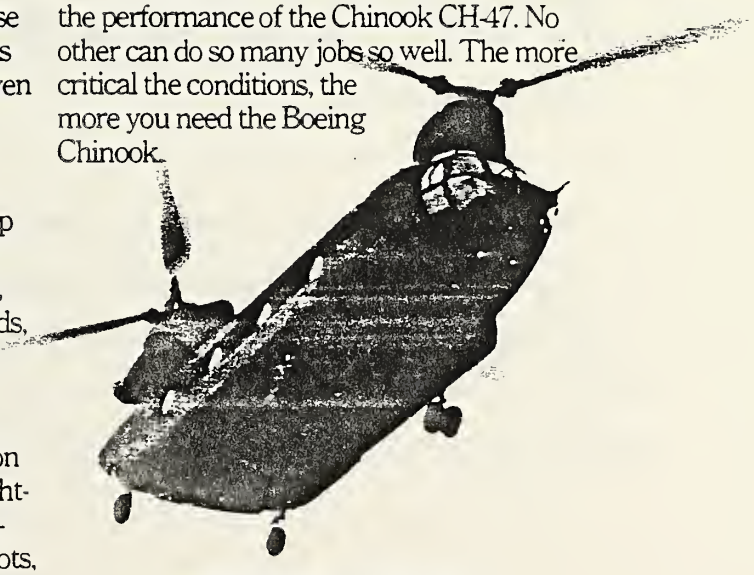
The Boeing CH-47 Chinook: the combat support reason.

As never before, the ground commander needs the sustained swift response to the lightning strike of modern weapons and tactics. The Chinook helicopter, proven in combat, gives him that capability.

Today's sophisticated tanks, highly mobile artillery, and attack helicopters require complex logistical systems to keep them going. And when the terrain gets tough, roads become blocked, bridges go, and fluid battle lines create surge demands, supply becomes a ground commander's nightmare.

But the Chinook can go where the action is. It'll bring in fuel and ammunition 10 or more tons at a time, redeploy 33 fighting men with weapons and supplies, leapfrog gun crew with field pieces at 100 knots, evacuate 24 wounded on litters, spot barrier material, bring in vehicles and armor, recover equipment, and more.

No other helicopter of its class matches the performance of the Chinook CH-47. No other can do so many jobs so well. The more critical the conditions, the more you need the Boeing Chinook.



BOEING VERTOL HELICOPTERS
THE LEADING EDGE
Philadelphia, Pa. 19142

(e) The necessity of assuring that the co-producer and the co-producers suppliers become and remain qualified manufacturers, must be kept in mind.

(f) We had to recognize that our partner was a manufacturing organization and that this imposed new and severe obligations upon us to perform, especially with regard to schedules.

(g) It is necessary to assure adequate attention to the co-producer, especially where the licensor's organization is accustomed to a single large customer like the U.S. Government, which naturally tends to preempt resources.

(h) We had to acknowledge the concept of mutual benefit as being essential to this type of partnership endeavor.

(i) Overcoming the reluctance to accept co-production by personnel who feared it as an interference with, and loss of, in-house or U.S. production.

In commenting on government participation Mr. Tuccillo pointed out that between two parties there exists a single direct relationship whereas between four parties (i.e., two firms and two governments there exists six relationships).

"Contemplating some current and prospective multiple party programs, our conclusion is that our commercial programs are the essence of simplicity to implement and manage."

Mr. Tuccillo felt this was evidenced from the total manpower required for both of Vertol's two party direct programs:

(a) Management Functions: Currently less than one man per program with about three at the peak period.

(b) Administrative Functions (primarily in Contracts): Currently a little less than one man per program with about four or five at the peak.

(c) Overall (excluding only our own Manufacturing): Currently three or less per program with about 15 or 20 at peak. This peak included the technical assistance team, which never exceeded 7 people."

Mr. Tuccillo went on to say that....

"We can only guess at the effort in a government to government program trying to achieve a similar result. We are able to operate with a high degree of autonomy and to engage in problem solving limited primarily by our imagination, our mutually compatible objectives and legal and economic restraints and all current government regulations.

Mr. Tuccillo further stated...

In conclusion, I believe that our successful experience with direct commercial co-production shows clearly that FMS is not always best. Despite the current tendency to emphasize FMS via policy action and the Humphrey

Bill, I believe that FMS for co-production should be a carefully deliberated decision and not an automatic response.

The author would supplement the above with several additional points based upon his discussions with Ed Ritti.

- The program was able to benefit from Augusta's considerable know-how stemming from many years experience in building U.S. helicopters under license, resulting in a very competitive second source.

- This included the usual skirmishing over license territory (and problems in defining it) further complicated by U.S. State Department's Office of Munitions Control (OMC) need to exercise its prerogatives in vetoing sales in an unstable third world.

- Cut back in U.S. production rate as second source was being kicked off in Italy allowed Agusta to procure surplus subassemblies and tooling in U.S.

- Agusta geared up its substitution of Italian content for sub-assemblies off the U.S. line at a very judicious rate, thereby minimizing cost penalties.

- Successful 10 year working relationship led to 15 year extension of license agreement to produce an improved version of Chinook.

- Second source effort to broaden the supplier base allowed for alternate sources to alleviate production bottlenecks, improve competitive bidding and increase the generation and flow back of improvements to the U.S.

[1]Some of these are designated 'NATO' Steering Committees, and some are not. There is little or no practical difference whether a given steering committee has this label or not.

[2]In addition there is a more recent licensed production project where the governments are participants, the Roland SAM system, wherein a joint control committee was also set up.

[3]NATO Council Resolution C-M(62) 18 on "Regulations for NATO Production and Logistics Organizations."

[4]Document, AC/259-D/374, AC/94-D/244 (Revised), dated March 25, 1974 promulgated by CNAD's Working Group in Industrial Property, and entitled "Guidance to NATO Procurement Authorities."

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[1]NATO's predessor, set up by the Brussels Treaty in 1948 including the Benelux countries, France and the U.K.

[2]See pp. 151 and 153-5, of Robert E. Harkavy The Arms Trade and International Systems. The Ballinger Publishing Company, Cambridge, Mass. 1975.

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[1]The U.S. and Canada supplied their aircraft (mainly T-33's, F-84's, F-86's and F-100's) with minimum or no payment while Italy was the only country from which the FRG made significant purchases, buying the F-86 Sabre, built in Italy under license. Only minor purchases, were made from the UK.

[2]Harlow, C. J. E., The European Armaments Base: A Survey; Part 2, National Procurement Policies; Defense, Technology and the Western Alliance, No. 2, the Institute for Strategic Studies, London, June 1967, p. 42.

[3]In 1963 two firms located in Bremen, Focke-Wulf and Weserflug merged to form VFW (Vereinigte Flugtechnische Werke). They were joined by Heinkel in 1965. In the late 1960's Messerschmitt, Beolkow, and later Hamburger Flugzeugbau (HFB, owned by the Blohm family) joined to form Messerschmitt-Boelkow-Blohm (MBB). Dornier has continued to be the only old line aircraft manufacturer to succeed in resisting the Government's pressure for merger.

[4]The one transnational merger, of the FRG's VFW and the Netherlands' Fokker, that was consumated, lasted for a decade, but has recently come undone as a result of usual mix of national political pressures that work at cross purposes in any such venture in the aerospace industry.

[5]Harlow, op cit., p. 45.

[6]A.H.C. Greenwood, "MRCA-The Future System of Military Procurement," RUSI Journal for Defense Studies, Vol. 117, July/September 1972, p. 5.

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[1]This is the authors condensation of the program's history, based almost exclusively on a document previously prepared in the Co-production Management

Office of the International Logistics Directorate of the U.S. Army Materiel Command.

[2]Case History of the M113 Armoured Personnel Carrier Italy Coproduction Project, November 1962-June 1970, Coproduction Management Office, Directorate of International Logistics, H.Q. U.S. Army Materiel Command, Washington, D.C., January, 1972, p. 2.

[3]FMC and the M113 have more recently become involved in a production program in another NATO European nation, Belgium. In July, 1979, the Belgian government selected the M113 A1 and the armored infantry fighting vehicle (AIFV) over French equipment. The contract was for 525 M113 A1's and 514 AIFV's and totalled some $520 million. As of early 1980 a definitive contract had yet to be signed due to problems in concluding offset agreements. Since the program did not involve sufficient quantities to justify substantial license production beyond assembly of the vehicles, a mix of internal and external offsets had to be resorted to. Since this Belgian program falls under Mode #6 (bilateral offset arrangements), not Mode #1 as with the Italian program, it is treated later in Chapter 11. Since the late 60's Mode #6 has become much more prevalent than Mode #1.

[4]AMC, op. cit. pp. 2-3.

[5]Ibid. p. 14.

[6]The 1976 GRC study on NATO Standardization and Licensing Policy cited the US-Italian M113 MOU as an example the typical emphasis that the US government has placed on those of its weapon systems being produced overseas being completely compatible and interchangeable with US produced systems, whereas the Europeans had shown less concern in this respect in those cases where they were licensors. The MOU ensured standardization by stating that:
The Government of Italy agrees to insure that all M-113 vehicles produced in Italy under the provisions of this Memorandum are manufactured in conformance with drawings, specifications and changes thereto furnished for the production of the M-113, under the system of measurements called for in the drawings and specifications, under United States standards of quality and precision and further agrees that such vehicles will be inspected and accepted under United States standards of inspection and acceptance. (GRC, op. cit., p. A-20)

[7]The same GRC study also cited the M113 MOU's flow-back provisions as a typical example (along with several others) of the licensor's need (whether US or European) to protect itself against the licensee's ability to improve on its newly acquired technology and thereby gain a competitive edge.
In the MOU - The Government of Italy agreed to furnish, at no cost to the United States Government, such information and rights as may have been generated in technical data, information and inventions, relating to improvements and modifications in the design of the M-113 derived through production of the M-113 in Italy. (GRC, op. cit., p. A-30)

[8]AMC, op. cit., pp. A-1 to A-6.

[9]Ibid, p. 4.

[10]AMC, op. cit., pp. 6-8.

[11]Ibid. p.8.

[12]Ibid. p. 3.

[13]Possibly as a result of experience during the NATO Hawk program?

[14]AMC, op. cit., p. 4.

[15]Ibid., p. 11.

[16]Ibid.

[17]Ibid., p. 8.

[18]GRC, op. cit., p. A-19.

[19]Ibid., pp. A-19 to A-20.

[20]Ibid., p. A-20.

[21]Ibid., p. A-31.

[22]AMC, op. cit., p. 8.

[23]Compare this to the production technology problems experienced in the reverse direction (Mode #4), specifically the Roland and RATAC projects.

[24]AMC, op. cit., p. 14.

[25]Another point worth comparison with technology flow in the opposite direction across the Atlantic (Mode #4), see the RATAC and Roland projects.

[26]AMC, op. cit., p. 14.

[27]Ibid., pp. 12-13.

[28]It was worth comparing this decision and its good results to the NATO Hawk experience and the contrary results, where the procuring governments had opted to save on costs through following normal AMC channels. This proved to be at the expense of schedule delays and as such meant considerable extra costs, as well.

[29]AMC, op. cit., p. 19.

[30] Ibid., p. 4.

[31]Ibid. pp. 4-6.

[32]Ibid., p. 6.

[33]Ibid., pp. 8-9.

[34]In October 1979, the U.S. finally got in step with its other NATO allies in agreeing to provide these quality assurance and source inspection, as well as contract audit services, without charge, if done so on a reciprocal basis.

[35]DO is one of two priority ratings applied to defense industry purchase contracts in compliance with Defense Material System (DMS) Regulations. DX is the other and higher rating within the DMS. DO and DX rated purchase contracts take priority over unrated ones. The DMS is the means by which the flow of materials is directed to the nation's defense, and R&D programs. This system ensures that these programs are maintained on schedule by giving them priority in the purchase of materials. In World War II, over a year and a half was required half to develop a fully effective system of industrial controls to support the war effort. This system of allocations and priorities was known as the Controlled Materials Plan (CMP), and provided the means

necessary to balance the available supply of industrial resources against military and essential civilian requirements while directing the flow of these resources in an orderly fashion calculated to maximize the military potential of the nation.

Despite the experience gained in World War II, when the United States entered the Korean War in the summer of 1950, it took one year for the National Production Authority to install an effective modified version of the Controlled Materials Plan to direct the flow of products and materials into essential programs. This was eventually accomplished under the authority provided in the Defense Production Act of 1950.

In mid-1953 as the Korean War was ending, both Congress and the Executive Branch of the Government realized the necessity of maintaining, in peacetime, industrial mobilization capability which could be quickly expanded to cope with any future emergency. As a result, the Defense Production Act was extended in 1953 and the authority has been continued since that time. Based upon this consensus, the Defense Materials System and the Defense Priorities System (DMS/DPS) were established on July 1, 1953 and have continued, with only minor modifications, to the present day.
(Defense Materials System and Defense Priorities System, U.S. Department of Commerce, Domestic and International Business Administration, Bureau of Domestic Commerce, December, 1976m pp 3-4.)

[36]Ibid., pp. 19-20.

[37]Ibid., pp. 11-12.

[38]In October, 1979, Congress enacted PL-96-92, International Security Assistance Act of 1979 which allowed the President is authorized to provide (without charge) quality assurance, inspection, and contract audit defense services under this section. In connection with the placement or administration of any contract or subcontract for defense articles or defense services entered into after the date of enactment of this subsection by, or under this act on behalf of, a foreign government which is a member of the North Atlantic Treaty Organization, if such government provides such services in accordance with an agreement on a reciprocal basis, without charge, to the United States government. Prior to the passing of this act the U.S. was the only NATO member state that charged for such services.

[39]Ibid., p. 12.

[40]Ibid, p. 20.

[41]This was evidently part of an external offset to help cover Italy against heavier than expected share of U.S. industry in the NATO Hawk program.

[42]AMC, op. cit., p. 21.

[43]Ibid.

[44]Ibid., p. 23.

[45]The method chosen for procuring these radios is yet another example of the options available in the 'make or buy' choice. In April 1964, the Italian firm, Scialotti, purchased a production line for these radios from the Budd Manufacturing Company in Philadelphia, and began production of the radios for the Italian Army, in the U.S. (This infusion of foreign capital into the U.S. defense industry has since become more widespread.)

[46]AMC., op. cit., p. 16.

[47]Ibid., p. 17.

[48]Ibid., pp. 16-17.

[49]Ibid., p. 16.

[50]As we'll see in the sub-chapter on Agusta's production of the CH-47, the value of this role is rather debatable.

[51]Gold flow was an important issue in such programs until the U.S. closed its gold window in 1971, and with launching of the current floating exchange rate system shortly thereafter.

[52]AMC, op. cit., p. 24.

[53]Ibid.

[54]AMC, op. cit., p. 24.

[55]Ibid.

[56]Ibid.

[57]Ibid., pp. 24-25.

[58]Ibid., pp. 24-25.

[59]Ibid., p. 25.

[60]Ibid., p. 25.

[61]The 72 F-5's purchased by the Swiss government in 1976 are assembled under license at the Swiss Federal Aircraft factory, Emmen, but since this program primarily involves external (non-military) offsets, it is treated in Chapter 11. The F-5 has also been involved in foreign assembly under license in both Taiwan and Korea.

[62]Aviation Week & Space Technology, March 16, 1970, pp. 46-7.

[63]Ibid., p. 47.

[64]Greece, Turkey and Norway were to receive their F-5's through MAP.

[65]For example, the Netherlands NF-5's are assembled by Canadair in Montreal, while a portion of the fuselage is built by Royal Netherlands Aircraft Factories Fokker (AWST, op. cit., p. 46).

[66]DMS Market Intelligence Report., 1979, p. 2.

[67]AWST, op. cit., p. 5.

[68]Ibid.

[69]Aviation Week & Space Technology, March 10, 1969, p. 85.

[70]Ibid.

[71]AWST (1970), op. cit., p. 47.

[72]Ibid., p. 50.

[73]DMS, op. cit., pp. 1-3.

[74]Aviation Week & Space Technology, January 7, 1974, p. 15.

[75]Ibid.

[76]Ibid.

[77]Aviation Week & Space Technology, February 26, 1968, p. 40.

[78]Aviation Week & Space Technology, April 13, 1970, p. 20.

[79]AWST (1968), p. 40.

[80]Ibid.

[81]Ibid.

[82]See Chapter 11 for the RF-4E project history.

[83]Aviation Week & Space Technology, Nov. 14, 1966.

[84]Aviation Week & Space Techology, Nov. 25, 1968, p. 19.

[85]Aviation Week & Space Technology, April 8, 1968, p. 28.

[86]Aviation Week & Space Technology, July 8, 5968.

[87]NATO Standardization and Licensing Policy, Vol. II, General Research Corporation, McLean, Virginia, Nov. 1976, p. A-23.

[88]Ibid.

[89]Ibid.

[90]Ibid., pp. A-23-24.

[91]Aviation Week & Space Technology, Nov. 28, 1968, p. 19.

[92]GRC, op. cit., p. A-24.

[93]Ibid.

[94]Boeing Vertol also acquired a manufacturing license for the MBB B-105 helicopter in the early 70's, but following payment of the licensing fee, never produced the system due to lack of sales. Vertol ended up being a distributer only, supplying technical reps, spare parts, and farming out maintenance work.

[95]Mike W. Olszewski, BAC International Operations, Memo dated September 20, 1978.

[96]Agusta's first helicopter program began in the early 1950's with the Bell 47 series (the 47G, 47G2, 47G3, etc., plus the 47H). Since then the relationship has expanded to include the Long Ranger AB204, the Jet Ranger AB206, the AB205, AB212 ASW, and most recently, the AB412. All except the AB47 and AB204 are still in production at Agusta. For Sikorsky this has included the ASH-3D, the ASHH-3F and as of recently the commercial AS-61.

[97]Aviation Week & Space Technology, January 30, 1978, p. 53.

[98]Customers of the V-107/CH-46 included the following: The Navy order for the U.S.M.C. assault transports in the CH-46A (160), CH-46D (266) and CH-46F (174) versions totalling 520 aircraft; U.S.N. ordered for its own use some 24 Sea Knights for utility duties in the UH-46A and UH-46D versions; the Swedish Armed Forces procured 13 Sea Knights, designated HKP-4, in 1963-64 in two versions, one for ASW and mine-counter measure purposes and one for search and

rescue (all powered by Rolls Royce engines however, two Bristol Siddeley Gnome H-1200 shaft turbines, unlike the all other versions which areof early 1982. of early 1982.

[99]The South Vietnamese had received 72 Chinooks directly from the U.S. Thirty-two of these were to be lost as a result of the collapse of the regime in 1975, with the balance of 40 having been flown out during evacuation and turned back over to the U.S. Army.

[100]The CH-46 Sea Knight has also been involved in a modernization program over the late 70's and early 80's. This version is designated the CH-46E and a conversion of 292 CH-46D/F models is planned for a cost of approximately ¼ of a billion dollars. This program would allow Sea Knights to operate through the 1980's. A more recent U.S.N. modification program, the Safety, Reliability Maintainability (SR&M) program, will actually extend the life of the 368 Sea Knight's until the mid-1990's.

[101]DMS Market Intelligence Report, "Boeing Vertol CH-47 Chinook", 1981.

[102]Ibid.

[103]Ibid.

[104]The U.S. Army has provided to Korea and Thailand four second hand CH-47A's each to which it still retains title. Korea was given a letter of offer through FMS channels for six CH-47C's at a cost of $31.4 million in early 1978 but it was never accepted. (Spare parts, spare engines and ground service equipment were also offered for an additional $8.7 million.)

[105]The status of Greece with regards to offset work is actually unknown to the author.

[106]The somewhat cumbersome FMS route wherein the USG buys the hardware and services and resells them to the ultimate customer, allows the foreign government to benefit from the U.S. government's leverage and expertise, both stemming from its own large buy. Moreover, FMS credits are often already established for a given government (though as with most recent Spanish buy of three more Chinooks, these credits can also be tapped for direct commercial sales).

However it is generally less time consuming and very often less expensive (i.e., no U.S. government administration fee) to go through the direct commercial sales route. This approach also offers greater flexibility in providing post-delivery support since the U.S. contractor can deal directly with the purchasing government and/or its supporting industry. The U.S. contractor also benefits from the specifications for a direct commercial sale being much simpler than the excessively detailed specifications issued by the purchasing U.S. military agency.

[107]DMS Market Intelligence Report, op. cit.

[108]In early 1982 this 12 month limit on the validity of any OMC export license was extended to 24 months for most cases.

[109]Export licenses to cover hardware and technical data associated with the commercial version of the Chinook, the Model 234, are obtained from the Commerce Department. The State Department handles only Munitions List items, all others go through the Commerce Department.

[110]Amendment #6 (March 1974) fixed the R&D recoupment charges to be paid the U.S. government for each aircraft produced by Agusta. The agreement basically filled in the blanks prior to the first aircraft rolling off the Agusta line, which occurred some 11 months later.

[111]Olszewski, op. cit.

[112]The R&D recoupment charge, totaling $1.5 million, was waived for the 15 Chinooks bought by Egypt.

[113]Credit was also given for two small pre-payments of $5,000 each.

[114]Anthony V. Tuccillo, Boeing Vertol's former Manager of Licenses and Commercial Contracts, Summary of Production Licenses, Kawasaki and Agusta, through 1976, January 10, 1977.

[115]Ibid.

[116]Interviews and correspondence with Ed Ritti, Boeing-Vertol's Manager Licensing and Export Controls, between March, 1981, and March, 1982.

[117]The royalties for the KV-107 program were 4% for all aircraft sales and 5% for the sale of spares.

[118]The first three nations in the Principal Territory (Italy, Austria, and Switzerland) are 'Category A' countries according to the U.S. State Department's categorization, with the remainder of the countries in the Principal Territory being 'Category B' countries. Export to Category A countries by either a U.S. firm or its foreign licensee is authorized indefinitely once the State Department has approved the original manufacturing agreement (i.e., licensing agreement); while authorization of 'Category B' countries is authorized subsequently by the State Department only on a case by case basis. Iran has since been deleted from Agusta's territory, at State Department insistance, by Amendment #12 to the licensing agreement.

[119]Amendment #5 to the License Agreement dated July 1972, made several adjustments in the formula for calculating the royalty while taking Boeing Vertol content in the Italian built Chinooks into account.

[120]Ritti, op. cit.

[1213]Ibid.

[122]Amendments #10 (July 1980) and #11 (April 1981) to the license agreement were required as a result of this transfer of Egypt and #12 (April 1981) included the ban on sales to Iran, as well as some changes concerning the Model 414 program.

[123]Ritti, op.cit.

[124]Reporting two times a year seems to be the most common practice for such license agreements, but with the KV-107 license, KHI reports quarterly. Once Agusta did inquire about the possibility of switching over to a quarterly report, Vertol was amenable, but Agusta never followed up.

[125]Ritti, op.cit.

[126]Amendment #4 superceded and canceled #1 (spelling out the 4 options of granting either limited or full proprietary rights for either a license

production agreement or a service agreement) and #3 (which covered payment terms and dates).

[127]At no time has Agusta expressed reservations concerning the fair market availability of third party parts or rights similar to reservations the British were later to express on two other Boeing programs—the NATO AWACS program and the MLRS competition, or the U.S. Government for the U.S. Roland program.

[128]Ritti, op. cit.

[129]Olszewski, op. cit.

[130]Ritti, op. cit.

[131]Ibid.

[132]In all other sections of this sub-chapter, when referring to C.A.G. Agusta S.p.A., 'Agusta' alone will be used.

[133]When the EMB-CH47C project started up SIAI Marchetti was not Agusta owned, only a major subcontractor to whose facilities Agusta assigned a sizable detachment of its own personnel.

[134]Ritti, op. cit.

[135]Ibid.

[136]Ibid.

[137]Ibid.

[138]As of early 1982 the U.S. Army and the RAAF were both interested in buying Logic's power steering control box. Boeing vertol has taken the position with the RAAF that it must buy through Boeing Vertol and cannot go direct since it is a Boeing Vertol Spec control item. Boeing Vertol must as such maintain a technical surveillance effort, the item impacting on fuel control and therefore flight safety. Logic has gone along with this position. Of course if the U.S. Army elects to go direct, it can (for both itself, and through FMS for the RAAF), but then this would involve the Army's assumption of configuration control responsibilities. In the two cases where Italian produced materiel is incorporated in U.S. Army Chinooks, the Italian Army quality assurance representative at Agusta performs the inspection at the request of the U.S. government's European DCAS office in the Federal Republic of Germany.

The only other case where the U.S. Army has itself approved a Vertol QSR approved change initiated by Agusta involved the air logistics rubber bladder tank ferry fuel system. These were originally developed by Agusta for ferrying Chinooks to Iran. The U.S. Army utilizes them for ferrying Chinooks across the Atlantic for its annual Reforger exercises in the FRG.

[139]Ritti, op. cit.

[140]Ibid.

[141]Ibid.

[142]Ibid.

[143]Ibid.

[144]Ibid.

[145]Ibid.

[146]Ibid.

[147]Ibid.

[148]Ibid.

[149]Actually coming after the KV-107 program in Japan, Boeing Vertol was somewhat surprised that their tool drawings were as complete as they were. The original build-to-print approach of Kawasaki Heavy Industries didn't work on tooling because the design was not yet mature. For the Italian program this was not a problem.

[150]These masters are actually tools in that they are parts that are as close as possible to the theoretically perfect part. They are selected from among an original production batch, carefully machined and kept in special storage. Periodically Q.C. will check a production part against the master. This often involves a set of masters. For example Agusta procured a set of three for each of the two rotor blades; a working master which was checked against an 'inspection' master which in turn was periodically checked against a 'gold' master.

[151]Ritti, op. cit.

[152]Ibid.

[153]It is naturally preferable to make duplicate shipments where only a minor cost is involved, than to argue over who lost what, where. A similar practice had been adopted with regards to minor purchased parts in support of the Japanese KV-107 license production program where nickle and dime issues constantly cropped up over quantities shipped and delivered. Eventually Boeing Vertol decided to act in order to minimize the problem and obtained a listing of all high quantity/low value items such as nuts, bolts and washers. One ship set of these items was sent over to Japan and provided free of charge to serve as a reserve pool against which Kawasaki could draw as needed. This diminished the problem considerably. In part due to better inventory control practices of the licensee, this problem has not been significant for the EMB-CH47C program.

[154]Ritti, op. cit.

[155]In one recent case Vertol Service Bulletin required a bolt change. However Agusta couldn't obtain them on the open market nor could Boeing provide them. As Agusta couldn't comply, a Vertol had to give Agusta schedule relief.

[156]Up through September 30, 1981, Agusta procurred from Boeing Vertol $476,302 worth of technical assistance and technical publications. For example special sales provisioning parts breakdown, and magnetic tape milar equipment (Agusta had originally requested that some of the documentation covered under the TDP be provided as milar, but then later realized they had forgotten to buy the necessary equipment to use it).

[157]Olszewski, op. cit.

[158]The first six months of technical assistance of a total of the 2 years each for the manufacturing planner and industrial engineer were not contracted for, as they were credited to the provision of a technical representative to Agusta

for 12 months as covered in the license agreement (Article 3.3.3.1.) and fee. (Actually there was a minor misunderstanding over this term 'technical representative' as this term equated with service rep at Vertol, but Agusta intended to mean a technician e.g. an industrial engineer or manufacturing planner). Agusta hand picked the original technical assistance team, the manufacturing planner and the industrial engineer.

[159]The two courses of 20 days each to which Agusta was entitled under Article 3.3.2 of the Agreement were used as credit against this training contract.

[160]As it turned out this was the only case of formal class room instruction by Boeing Vertol in Philadelphia.

[161]U.S. labor unions have to be dealt with once training leaves the classroom and goes out on the shop floor. In support of its licensees and customers in the area of training Boeing Vertol has found the unions to be generally quite cooperative once the situation has been explained. Though management doesn't always get all it wants, the unions will go along as long as they don't perceive the activity as job threatening. It is important however to make prior arrangements with the unions.

[162]Ritti, op. cit.

[163]Ibid.

[164]Though the Italians were comfortable with the use of a U.S. based index (this not being an issue), the Japanese insisted on the use of a Japanese based index for the KV-107. In any event neither index has varied all that much from the other overtime.

[165]In contrast to Boeing's straight line approach, Bell Helicopters follows a different philosophy in setting its royalties with Agusta and other licensees. Bell starts it's royalties out relatively low and builds up gradually while the learning curve is bringing costs down. In addition to making it easier for initial sales to get off the ground, this diminishes the initial strain on resources caused by payment of the license fee.

[166]Ritti, op. cit.

Chapter 7

MODE #2

LICENSED PRODUCTION BY A MULTINATIONAL CONSORTIUM IN EUROPE OF A SYSTEM DEVELOPED IN THE U.S.

This Mode involves two distinct waves. The first swelled between 1958 and 1962 and had disappeared by the end of 1967. The second wave has only recently began to swell as of 1976.

The first wave involved the production of the F-104G fighter, the Hawk surface- to-air, Sidewinder air-to-air and Bullpup air-to-surface missiles.[1] The second wave involves the Super Sidewinder air-to-air missile, the copperhead 155mm projectile, the MLRS and, at least initially, the Patriot surface-to-air missile system.

The post-Sputnik crisis, the need for the U.S. to transfer a large quantity of major new weapon systems to its European allies through the MAP program, while this program was being phased out, led to a U.S. willingness to shift its assistance more toward technology transfer and the production of the systems in Europe primarily at European expense. The Continental Europeans, having reached economic recovery, were anxious to move forward through investing in such high technology areas. During this same period the U.K. still had its own competitive systems (as did France to a lesser extent) and had not yet faced up to economic realities of its financial resources no longer being capable of matching the technological capabilities of its national industrial

base. The U.K. therefore participated in only one of the smaller programs, the Bullpup. This Mode was instrumental in paving the way for Mode #3 (European joint development).

The second, and so far smaller wave, began with the renewed U.S. concern for NATO RSI, but in the face of the much more complex scenario of the mid and late 1970's. Representative of this, the F-104G consortium countries have broken off in two directions: the FRG and Italy joining with the U.K. to jointly develop and produce their F-104G replacement, the Tornado MRCA, (Mode #3), and Belgium, Denmark, the Netherlands, and Norway are involved in producing their F-104G replacement, the F-16, as part of an integrated transatlantic effort (Mode #7).

The 4 projects treated in the first wave of this Mode represent 2 major approaches to international procurement. All four projects came under supervision of an international project office (NPLO) but the two largest projects involved the project office's coordinating the utilization of all participating nations procurement systems. The F-104G and Hawk differed in that for the former the NPLO had no industrial counterpart to coordinate the four groupings, fulfilling this function itself, while in the latter case there was an international prime contractor. As for the two smaller projects the international project office worked through only one nation's procurement system, that of the firm acting as prime contractor, all other national industries interfacing as its subs. The Sidewinder and Bullpup projects are similar in that one nation was ordering the majority of the systems being collectively procured. They differ however in that in the case of Sidewinder

the logic of this meant that a firm from the major nation acted as prime, whereas in case of Bullpup it was a minor participant's industry that acted as prime.

A. THE NATO HAWK PROJECT

1. Background

a. The System

The Hawk is a low-to-medium altitude, all weather, surface-to-air missile system designed by Raytheon for the U.S. Army. A Hawk battery can be operated autonomously or can be netted into area defense systems, as are the allied systems in central Europe. The system is mobile on trucks or trailers, as well as being helicopter transportable.

The Basic Hawk is based on a U.S. military requirement emanating from the Korean War in 1953. Raytheon was selected by the U.S. Army from among four competing firms to be the prime contractor for research and development of the Basic Hawk.

b. 1957 - Economic Recovery, Crisis, and a U.S. Initiative

As part of the on-going efforts to strengthen NATO's defense shield during the mid-1950's, the U.S. agreed to provide several missile systems to European nations on a grant aid basis. However, due to the high cost of such systems, and with Western Europe's economy approaching recovery, it was decided to have the missiles produced in Europe. This resulted in the introduction of the Sample Weapons Program in January, 1957. This involved the offering, free of

single continental European nation had both the industrial and financial resources nor a large enough order base to accept the program. As such the U.S. initiated discussions with the Europeans on the possibility of joint production of several systems. Here we see the beginnings of the first integrated multi-national production under license of a weapon system and a break from the previously common course of one nation's industry unilaterally producing a system under license for its own government's inventory and/or for export.

Competing with the Hawk, at this time, for selection for common production was the British systems, the Thunderbird and Bloodhound, both of which were judged as superior to the Hawk by their own countrymen.

With the shock of the first Soviet Sputnik in 1957 (preceded by the Suez and Hungarian crises the previous year), Alliance solidarity was at a peak. In December, 1957, at the heads of government meeting of the North Atlantic Council (NAC) in Paris, Secretary of State Dulles recommended that the Sample Weapons Program be replaced by a number of multinational weapons production programs. As a further inducement to the adoption of U.S. systems and the rapid initiation of programs, he also offered the possibility of the U.S. purchasing a portion of the output for MAP purposes.

Subsequently, between 1959 and 1962, three missile projects were launched involving license production in Europe of U.S. systems by multi-national consortia. These were: the Hawk surface-to-air missile system; the Sidewinder AIM-9B air-to-air missile system; and the Bullpup air-to-surface missile system. Though not a part of this initial effort two other non-missile projects also followed:

the production of the Lockheed F-104; and the Mark 44 ASW torpedo (the latter by a Franco-Italian consortium).

c. 1958 - The Ground Work is Laid

A necessary prerequisite to such arrangements, involving highly classified equipment and techniques, private American property rights, and so forth, was a series of protective agreements. Some of these agreements had already been developed over the years under NATO auspices, while others had to be negotiated specifically for the individual projects. In order to initiate the programs those NATO governments expressing interest were invited to send representatives to the U.S. to shop around.

After the European NATO delegation visited the U.S. in early 1958, Belgium, France, the FRG, Italy, and The Netherlands all expressed further interest in the Hawk missile system. At this time, the Hawk was probably the most advanced electronic weapon system in the world.[2] At this point the UK decided to drop out, choosing instead to continue with the development of its reasonably successful and directly competitive Bloodhound system.[3]

In early 1958 the five interested nations - the FRG, France, Italy, The Netherlands, and Belgium (the recently formed European Economic Community (EEC), minus Luxembourg) accepted the U.S. government's offer to provide free of charge government-owned property rights for the manufacture of the Hawk. The five participating European nations and the U.S. set up a Working Group, AC/139, in July, under NATO's Defence Production Committee (soon to be renamed the Armaments Committee) to determine how they should approach a joint project. The U.S. took the viewpoint that it was to be essentially a European

project, limiting itself to pointing out technical complexities and problems involved, as well as the importance of placing program emphasis on the industrial rather than governmental participation. The U.S. negotiators emphasized that its role was to be that of a contributor, not a leader or coequal participant.[4]

The European members of the Working Group, unlike the American member, were led by top officials from their respective military procurement agencies. These were the same men who had visited the U.S. and selected the Hawk. The head of each national delegation to the Working Group, except for the FRG, was also head of the agencies responsible for procurement research and development for his military services. The German representative was a senior civilian lawyer in the German Defense Procurement Agency (BWB).[5]

That same summer (1958), a course under the auspices of the NATO Assistant Secretary General for Production and Logistics, was conducted in engineering and production of guided missiles. Over 200 government and industry people attended.

Early in these intergovernmental discussions, each European government selected a national firm as its leading industrial participant, each becoming one of the five national prime contractors (NPC's). As emphasized by the first of the U.S. liaison officers to the project, Lt. Col. M. S. Hochmuth,[6] the greatest single attribute that these firms selected to collaborate held in common, was that they were all competitors within the nascent EEC. In September 1958, representatives of these firms were sent to the U.S. to acquaint themselves with the Hawk system.

By late autumn, 1958, the NATO Hawk Working Group had made sufficient progress in defining the broad program objectives, establishing the financial bounds, reconciling these objectives with military requirements, and developing a general mutual understanding. National industrial particpation was to be allotted in line with national expenditures, which were, as of this date:

Belgium	10.7%
France	35.7%
FRG	32.1%
Italy	14.3%
The Netherlands	7.2%

Although production was distributed in proportion to orders, the aim was that each nation would receive all of the know-how. But then, the production of some parts was bound to provide more valuable technical experience than others. This consideration had to be balanced with that of minimizing duplication in production, and maximum use of existing facilities. Other considerations included the prestige attached to the location of the assembly line for the missiles, as well as the potential political issues of export and end-use (e.g. if produced in the FRG and needed by France in a North African conflict).

As the five participating governments (PG's) were negotiating over how to distribute production among themselves, legal and other experts representing each PG and the U.S. came together to draw up the intergovernmental agreement (or MOU) known as the Technical Arrangements.

> Significantly there was only a modicum of input from the "working level" on the U.S. side - the Army's Redstone Arsenal. Information on requirements and technical data reached the U.S. negotiators through a multi-layered bureaucracy. Whereas on the European side there were fewer such layers, but heavier involvement by the foreign ministries.[7]

d. 1959 - The Project is Launched

The Industrial Conference sent its report, known as HK42, to the Hawk Working Group on February 7, 1959. Since each firm's representatives had been in constant touch with their own governmental service over the intervening two month period, HK42 was quickly accepted without modification by the governments.

This was followed by the formation of a Panel of government experts which was charged with organizing the intergovernmental side of the house, and initial steps to set up a European Prime Contractor were taken. By mid-February 1959, the five participating governments (PG's) had laid down the ground work and made a formal proposal to the U.S. The proposal to the U.S. contained the firm commitments of the participating governments, recommended production allocations, and outlined the extent and type of U.S. assistance required. In

negotiating with the U.S., full use was made of the international Staff/Secretariat's office of the Assistant Secretary General for Production and Logistics.[8]

The U.S. Secretary of Defense's response to the proposal was favorable, but also set six firm conditions for the PG's:[9]

(1) Procure a specified number of Hawk battalions;

(2) Arrange with their own funds, with the exception of specialized tooling and test equipment only available in the U.S., the setup of production facilities;

(3) Purchase certain privately owned property rights and technical information from the U.S. owners;

(4) Adopt U.S. equivalent security measures;

(5) Credit the U.S. government for the Government furnished components incorporated into the European produced systems;

(6) Insure the flow-back to the U.S. Government of rights and data relating to any European improvements in the Hawk system.

In return for making the above commitments, the U.S. agreed to furnish the following Grant Aid:

(1) Samples of production models to be used in proving out European production and testing;

(2) Industrial schooling;

(3) Technical documentation;

(4) A portion of the required engineering manhours;

(5) Specialized tooling and test equipment not available in Europe;

(6) A license covering U.S. Government-owned proprietary rights and technical information relating to Hawk.

On May 6, 1959, the five national prime contractors (NPC's) established under French law the Societe European de Teleguidage (SETEL), to act as the European Prime Contractor (ECP). Almost simultaneously France announced that, due to budgetary problems relating to the War in Algeria, she was reducing her share in the program by 67%. Appalled at the thought that the program might abort, the U.S. took the lead in hurried negotiations. By the time the dust had settled later in May:

(1) The U.S. came through with its prior commitment to buy some of the systems produced for MAP purposes (for Denmark and Greece), this would involve 15.4% of total program production;

(2) The Netherlands increased her share from 7.2% to 11.5% bringing its share up to the level of Belgium's (and now France's as well);

(3) The FRG agreed to let French industry have 22% of its share, because German industry was operating at maximum capacity (while French industry was suffering from overcapacity).;

(4) As a result the total quantity to be produced was reduced by only 7%, even though the French reduction had amounted to 24.2% of the original program.

This left a final distribution of the program's procurement and production shares along lines that were:

(1) Proportionate for the U.S. and Italy at 15.4%, and Belgium and The Netherlands at 11.5%;

(2) Whereas France as well, was now procuring only 11.5%, she had a production share of 19.3%;

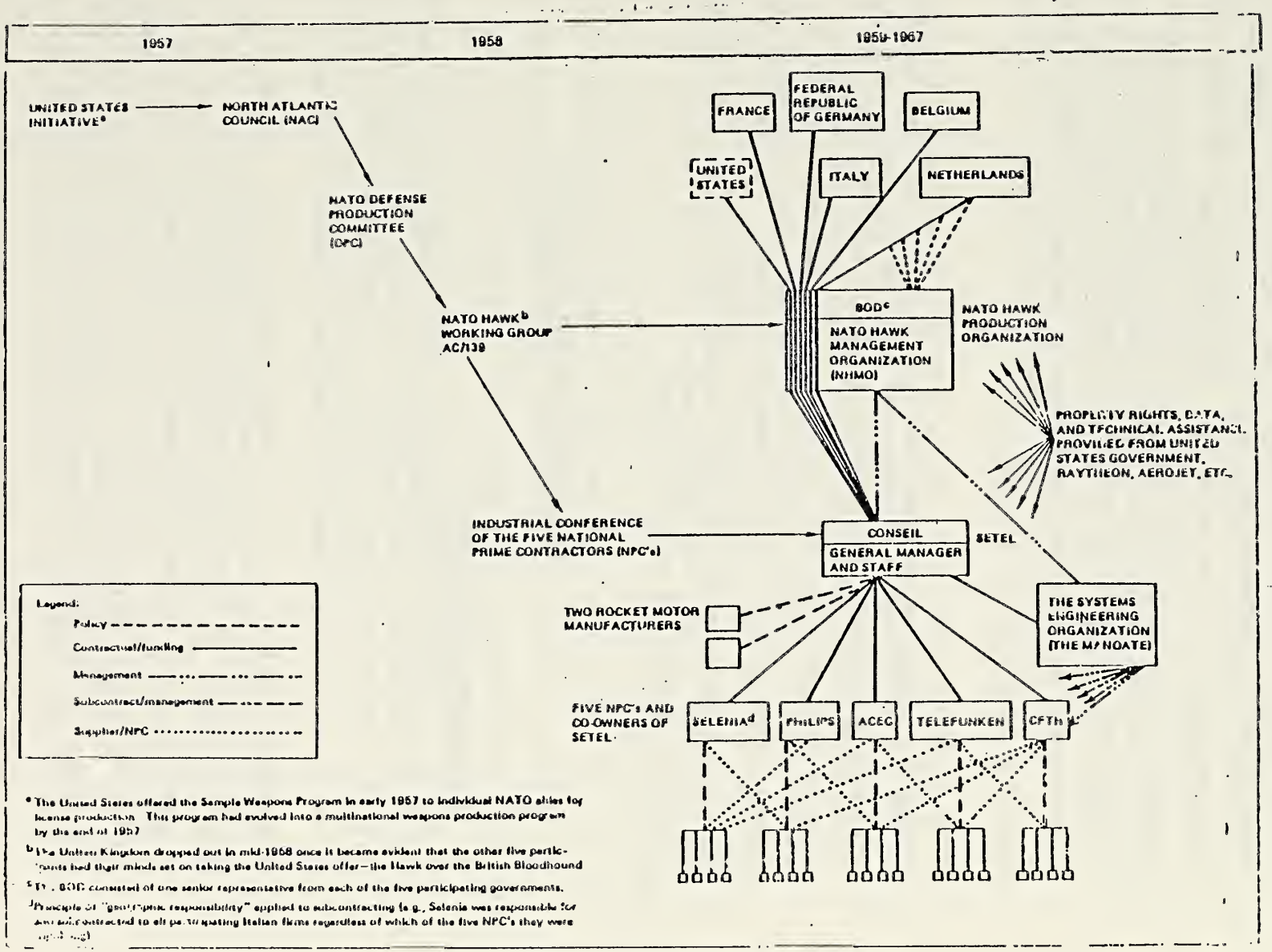
(3) While the FRG was procuring 34.7%, her production share now came to 26.9%.[10]

When the following month, June 11, 1959, the NAC approved a resolution incorporating the terms, conditions, and proposals previously referred to, the program was officially set in motion.

This resolution also provided a charter for the NATO Hawk Production Organization (NHPO),[11] and agreed on binding conditions that would from henceforth penalize any government reducing its order. The same month the NHPO was established in Paris, and the Department of the Army set up the NATO-Hawk Liaison Office as an element of the Hawk Production Management Office, U.S. Army Missile Command. The NATO Hawk Liaison Office's mission was to provide technical liaison between the NHPO and all U.S. Government agencies and industrial contractors involved in the European production of the Hawk system.

e. 1960 - 1967

Starting in mid-January 1960, Raytheon conducted courses at a training center which it had established in Andover, Mass., in order to familiarize European governmental and industrial personnel with the major components of the Hawk system, and to indoctrinate them in the manufacturing and testing techniques involved.[12]



[a] The United States offered the Sample Weapons Program in early 1957 to individual NATO allies for license production. This program had evolved into a multinational weapons production program by the end of 1957.

[b] The United Kingdom dropped out in mid-1958 once it became evident that the other five participants had their minds set on taking the United States offer—the Hawk over the British Bloodhound.

[c] The BOD consisted of one senior representative from each of the five participating governments.

[d] Principle of "geographic responsibility" applied to subcontracting (e.g., Selenia was responsible for awards contracted to all participating Italian firms regardless of which of the five NPC's they were [illegible])

European Production of the Hawk Missile System

It was not until March 31, 1960, that the five PG's and the U.S. finally signed the multi-lateral agreement, entitled the Hawk Technical Arrangements, which bound them formally to the project and its organization. "A prime cause of this delay was France's unwillingness to sign a prerequisite bilateral agreement with the United States which recognized the legal corporate entity of NATO subsidiary bodies and their right to contract."[13] This issue will be dealt with in more detail in section 8.

In September, 1962, series production finally began. The first batteries were in service by mid-1963, and production continued into 1967, when all missiles originally ordered by the PG's and the U.S. had been delivered and the program reached the end of its life as a production program. Over 500 European and 200 American manufacturers had been involved, with a core of 60 contractors employed to execute the production tasks.

2. Nato Hawk Production Organization

a. NATO Document, AC/139-D/8[14]

Following the submittal and acceptance of HK42 in February 1959, the Panel of Government Experts was formed by AC/139. It received as terms of reference: define the governmental responsibilities; and recommend the structure of the organization required to fulfill these responsibilities. The additional guidelines given the group were: assume industrial organization as recommended by the Industrial Conference in HK42; general policy would be formulated in a multinational board of directors; and beneath the BOD would be a management office directly charged with execution of the program.[15]

An early suggestion offered by a U.S. Government official in 1958, was to create a supranational organization which would be financed by the 5 PG's. Furnished with its own complete staff, this agency would organize and supervise the program, bypassing the national armaments services. The PG's rejected this out of hand, being unwilling to lose a direct say in the management of the program—a question of national sovereignty.

As previously mentioned in Chapter 4 the Central European Operating Agency (CEOA) for managing the NATO pipeline system in Central Europe set the pattern for future NATO subsidiary organizations. NATO HAWK was the first weapon system project to follow such an organizational approach.[16] With the NATO pipeline it had taken three years of negotiations, 1954-1957, to resolve the organizational problems. Most members of the Hawk Panel of Government Experts had been a part of the earlier struggle with the conflicting demands of common control and centralized authority versus national sovereignty. For most NATO governments and most panel members the necessary but painful adjustment in attitude had already occurred. This allowed them to complete within two weeks their report to the Working Group, NATO Document AC/139-D/8, on the organization of the governmental consortium that would execute the planning, financing, and procurement functions of the program.

Following the Working Group's guidelines the Panel borrowed the NATO pipeline solution of a multinationally staffed management office, headed by a General Manager, to act as the executive arm of the BOD. Due to the much greater complexity and uncertainty involved in weapons system production, the Hawk organization would naturally become proportionately more complex than the CEOA. This led the Panel to recommend that the BOD be supported by committees of

experts in such specific areas as taxes, finance and accounting, business law, engineering, and logistics.

b. The BOD

Within the NATO Hawk Production Organization (NHPO), the Board of Directors consisted of one member from each of the five PG's. After approval of the NATO resolution in June, 1959, in the interest of continuity, each PG named its senior Working Group member to the NATO Hawk Board of Directors (BOD). As previously indicated these men wore two hats. All but the German members were under their other hat, the military chiefs of their Army or Air Force materiel agencies. One of them also acted as Chairman. The Chairmanship rotated annually. Since the U.S. had previously opted out of a co-equal role, its respresentative, the U.S. Army's NATO-Hawk Liaison Officer, sat in as an observer only. The BOD reported directly to the PG's. As with all such subsidiaries of NATO, the NATO Board of Auditors had audit authority, being responsible only to the NAC. The BOD met usually at monthly intervals at Rueil Malmaison, near Paris, but these meetings became less frequent over time as the scope of responsibilities delegated to the Management Office gradually increased.
A U.S. Security Officer was also assigned full time to the Hawk Management Office, to insure the proper protection of classified information. The U.S. Government maintained the right to veto on all matters of security for Hawk.

In line with the Panel of Government Experts recommendations on decision making, the BOD was to have unqualified overall supervision and decision making authority. Decisions were to be reached by a three-fifths majority with each participating government having a vote weighted in proportion to its share of the overall purchase, provided that three of the five governments also voted with the

weighted majority. In commenting on this, a former U.S. liaison officer for the program, Lt. Col. Hochmuth stated.

> This was an ingenious and fair formula. However, in matters of major policy (undefined) and decisions involving financial commitments unanimity would be required. In practice the voting formula was never used and the "NATO Method" of unanimity prevailed.17

NATO's mechanism for reaching a decision in the Council (and at lower levels), termed the "NATO Method", was described by NATO's first Secretary General, Lord Ismay:[18]

> The Council had no written rule of procedure, nor has the need for such rules ever been felt... there is no voting. When governments hold divergent views the negotiation continues until unanimous agreement has been attained. There is no question of, say, ten nations forcing four to do what they do not want to do. The Council are no super-national body, their members are respresentatives of sovereign states. It is true that unanimity is not always achieved without considerable patience and a good deal of give and take...19

Another description of the "NATO Method" as it applied to the Council, as well as at those levels below the Council, is the following:

> Deputies had to learn and practice the technique of reaching unanimous recommendations by twelve men without formal vote. Each Deputy was briefed by his government to put their point of view. Each reported back to his government what modification of his instructions was needed to secure agreement, and so brought to bear on his government the pressure of opinion in NATO. Eventually a common view was reached.20

Nevertheless the necessity of unanimity did not prove to be a critical problem. Though some decisions were delayed, this was not nearly as serious an occurrence as with its industrial counterpart, the SETEL Conseil. The Board developed strong internal confidences among its five national representatives.

The need to provide each other with arguments to overcome difficulties with their respective governments, proved to be an effective cohesive force.

Of special interest are the roles played in the BOD by the members from the two smaller nations—The Netherlands and Belgium. Hochmuth made the following observation in this regard:

> Often during a particularly difficult debate between the larger countries, on such subjects as reducing the rocket motor production lines from 3 to 2, allocating production of a new radar, or selecting a single site for checkout and delivery of complete systems, it would be the Belgium or Dutch board member who played the role of arbitrator or concilator. Frequently such members set the example of project welfare above national interest and thus brought the other countries around.21

In his analysis of the NATO Hawk BOD and the manner in which decisions were reached, Lt. Col. Hochmuth came to the following interesting conclusion, one that is possibly of long term significance:

> It is precisely on the ethical and moral values of Europeans that the diffuse and subtle integrating forces are having their greatest effect. Unfortunately, the effect on Americans is far less important. For almost 3 years the author attended meetings of the NATO Hawk Board of Directors. It was singularly impressive to observe the members constantly search for a compromise for the sake of the project. In many cases these were compromises of national position. There is no question but that with few exceptions these men were able not only to reach a common solution, but to obtain national approval as well.22

This ability to obtain national approval was in good part a function of their prominent positions within their respective national services, allowing most of them considerable discretion.

c. The NATO Hawk Management Office

Beneath the BOD within the NATO Hawk Production Organization (NHPO) came the integrated multinational NATO Hawk Management Office (NHMO), acting as the BOD's executive agency. The NHMO, or the "Bureau de Gestion Hawk' as it is more commonly known, is also located at Rueil Malmaison, but not at the same location as the BOD.[23] In the NHPO, it was the NHMO that found itself making all but the

most important decisions. The BOD managed to confine itself to policy, leaving the executive job to the Management Office.

The Panel of Experts had laid out the duties of the NHMO's divisions in considerable detail. Since one of its primary principles had been to keep the overall size of the management office at a minimum, it had laid stress on delegating work to existing national staffs and agencies wherever possible. As such the staff never exceeded 118 personnel. The NHMO did come under attack from some quarters for being too large and unwieldly, however, in light of the fact that the total cost of the NHMO had come to only $3.65 million dollars for its first six and a half years, which was well under 1% of the total project cost, it would seem that this was not terribly excessive. The issue of a balanced use of existing national capabilities is faced by all such programs. The aim is to rely to as great an extent as possible on existing national agencies as aids to the transnational agency, while minimizing the size of the multinational staff.

The NHMO was a hierarchical and functionally arranged organization. The five functional divisions were:

- The Engineering Division, headed by a French officer;[24]
- The Quality Control Division, headed by a German civilian;
- The Planning and Production Division, headed by an Italian officer;
- The Contracts and Licenses Division, headed by an Italian officer;
- Finance and Price Control Division, headed by a Dutch officer.

Later, Administrative Security and Linguistics Services branches were added. In 1963 a Logistics Division was created as well, be it somewhat tardily.

Hochmuth, in his 1974 book, Organizing the Transnational, attributed the fact that the BOD was able to confine itself to policy primarily to the unique personality and skills of the General Manager, a retired Lt. General of the Royal Dutch Air Force, Lt. General W. J. Reijnierse. Once the BOD had been formed it proceeded to select a General Manager, choosing Lt. Gen. Reijnierse, who having been head of the Dutch Air Force material agency and head of the Dutch delegation to the NATO Hawk Working Group, had just retired. In Hochmuth's words he was "relatively young, forceful, very aggressive, bright and quick".

This selection of a Dutch national as general manager of the NHMD was also attributed with helping to offset identification of the agency as "French".

Upon accepting the task of general manager, Reijnierse set about building a top quality staff. Reijnierse met considerable resistance from the governments in his fight to get the highly capable officers that had previously caught his eye, assigned to the NHMO. Although not all of the countries could or would assign the exceptional personnel that Reijnierse wanted, he refused to accept or retain men of below-average competence. During the negotiations for his staff, he was dealing directly with his new bosses, now former colleagues, of the BOD. In its international status the staff was looked upon as 'abandonant toute preoccupation nationiale'. Reijnierse and his staff soon became involved in the negotiations to refine production allocation and in arranging for indoctrination and training visits. Likewise they were involved in license negotiations between

SETEL and Raytheon, in the drafting of the Technical Arrangements, and above all in discussing the production contract with SETEL.[25]

Although all functions within its sphere were controlled by the Management Office, it is still important to keep in mind that General Manager and his staff had no explicit authority to act as a free agent on behalf of the participating governments. Since all policy decisions had to be reached unanimously by the governments acting through their representatives on the BOD, the General Manager had a key, if highly ambiguous and delicate role to play.

Another very important strength of NHMO was its power to withhold funds from SETEL by not authorizing national payment. It could withhold authority for future spending and it could (and did) delay reimbursement for costs incurred.

One of the multinational committees of experts that was to assist the BOD attained considerable importance from a management point of view. This was the Group of Inspectors, serving as a multinational inspection and audit body, surveying and spot checking accounts, accounting methods, cost, payments, etc. However, since the areas inspected also lay within the domain of the NHMO, the Inspectors' reporting their findings directly to the BOD, became a major source of friction within the program.[26]

The following pages are quoted from Milton S. Hochmuth's Organizing the Transnational: The Experience with Transnational Enterprise in Advanced Technology.

> The BOD continued to meet about once a month, and interim negotiations were carried on between the delegations at NATO headquarters. Since no one government could speak for all, it was clear that NHMO would have to be the governmental focal point between the industry and the 5 governments. By aggressively taking the initiative in all actions

concerning the governments and assiduously and meticulously explaining his action to the BOD, Reijnierse quickly obtained the confidence of the board. His goals were clear. He would keep the costs of the program to a minimum for his "bosses", extract the best possible terms from industry, "Europeanize" production quickly, and hammer the program through as rapidly as possible, for time was money. Moreover, it was a matter of strong personal pride for him to show his ability. Unfortunately the United States, having declined a co-equal role in the program, was not considered by Reijnierse to be one of his "bosses." This fact had an important effect on his strategy. To minimize costs to the European governments, he would shift costs when possible to the United States by taking advantage of the loosely worded grant-aid promises. Another route was to maximize Raytheon's and other U.S. contractors' services at a minimum cost by getting personally involved in the license negotiations. By late 1959 he had seized the strategic initiative, and the BOD was more than content with his performance.27

The confidence of BOD in Reijnierse was constantly reinforced. As previously mentioned, he had handpicked a first-class staff. Furthermore he now obtained BOD authority to promote the staff (who held NATO civil service rank and pay status) as he saw fit. Thus he could financially reward the better performers, sound their praises to their old (and future bosses) or the contrary. In almost every case his key managers were much better paid than when they were in their national services, besides which NATO pay was tax free. His was an authoritarian organization cast along European military lines. Although national loyalties were not eliminated, they were subordinated to program loyalty. Not all, however, was perfection inside NHMO. Relations between key middle managers were not uniformly harmonious. As in any growing organization made up of aggressive and competent men, jurisdictional disputes arose which led to interpersonal tensions. As an astute manager Reijnierse was not entirely unhappy, for he stood to profit from such conflict as long as it proved constructive for NHMO as a whole.28

Personalities of the board members were important factors in the organization. Through their prominent positions in their services, most board members had considerable discretion and autonomy. It was to Reijnierse's credit that he was sensitive to their differences and could take advantage of them. Moreover NHMO religiously kept the technical and administrative bureaucracies of the 5 governments informed and involved. Since these agencies were the legal clients of SETEL and moreover were in contact with their respective NPC's, maintenance of good relationships was absolutely indispensable. Meetings were held regularly, and their advice was solicited and used. Thus the pressures of these national bureaucracies on the board members were positive factors for NHMO. In the event of dissension, NHMO clearly used its systems responsibility as a weapon. In matters of agenda, methods of operation, or in any other aspect of the venture, it was always NHMO which took the initiative and held on to control of the total program.29

> Reijnierse carefully avoided allying himself with any one board member or indeed any other single individual. Rather, he used the meetings of the BOD (plus bilateral discussions, phone conversations, and dinners) to constantly identify himself with the BOD as a whole. It was this more than anything else that created a feeling that all countries' interests were being equally guarded.30

d. The U.S. NATO-Hawk Liaison Office

Relations between the NATO-Hawk Liaison Office of the U.S. and the NHMO were also of importance. The Americans and Europeans did not always agree on how to manage their procurement activities, yet the U.S. Liaison Office and the NHMO staff were able to maintain an effective relationship. Notable among its activities were the following:

- Technical definition of European produced Hawk equipment, and procedures for controlling the interchangeability with U.S. produced equipment;

- Expediting deliveries and the solution of technical problems requiring assistance from U.S. government agencies and firms, and;

- Planning for post production logistics support, e.g., the policy on competitive procurement of spare parts and retrofit kits; the procedures and facilities for calibrating Hawk equipments.

3. Formation of SETEL

a. The Selection of Industrial Participants

Early on in the 1958 discussions of Belgium, France, the FRG, Italy and The Netherlands with the U.S. on the licensed production in Europe of the Hawk

system, each of the European governments had selected a firm to be that nation's leading industrial participant, i.e., its National Prime Contractor (NPC). Each firm would be responsible for its nation's share of the production, be it in its own facilities or that of national subcontractors. For example, Selenia was responsible for all Italian firms, be they subcontractors to the Italian, French or German NPC. The NPC's were also to serve as the national repositories of the know-how received and therefore key agents in the future development of technology.

The Netherlands chose Phillips, the FRG chose Telefunken, Belgium chose ACEC,[31] France chose Compagnie Francaise Thomson Houston (CFTH), and Italy chose Micro-lamda (renamed Selenia shortly thereafter). The first four were privately owned as well as being their country's major electronics company. Italy's choice of its National Prime Contractor (NPC) was different in both these respects. Micro-lamda was located in Naples in the underdeveloped South, and benefited from the Italian Governments development policy favoring this region. Selenia was owned 45 percent by the government owned Finmecanica, 45 percent by Raytheon (the licensor of the Hawk system) and 10 percent by Fiat.

Both the French and Italian NPC's had also been heavily involved in the U.S. Off-Shore Procurement program, while the Italian NPC also had the advantage of experience in working directly from Raytheon's U.S. drawings.

b. The Industrial Conference's Terms of Reference

One of the guiding principles in Hawk planning had been to limit, as much as possible, the participating government's (PG's) part to matters of financing, policy, requirements and procurement. The aim was to leave to private industry the responsibility and control of actual management and production. To come up with an adequate industrial organization, the NATO Hawk Working Group set up the Industrial Conference in late 1958. The terms of reference for the Industrial Conference were:

(1) To recommend on the allocation of production between the NPC's on the basis of the financial guidelines and the electronic/mechanical ratio of 65/35 previously agreed to by the Working Group, while also taking into consideration the goal of minimizing duplication and additional investments for tooling, test equipment, etc., beyond that to be provided by the U.S. through MAP.

(2) Study all possible organizational solutions at the industrial level, considering but not restricting itself to the government proposals.

(3) Consider and answer two specific issues:

(a) Is internationalization of the European prime contractor consonant with an acceptable degree of productive efficiency?

(b) Would the formula of a single national firm as European prime contractor provide equal know-how to all five participating national industries?

In addition to this, the Industrial Conference was also requested to provide recommendations concerning the allocation of production among the participants.

c. Three Organizational Options

Prior to the convening of the Industrial Conference, the five participating governments had each prepared national positions as to their preferred organization of the industrial effort which were drawn up in NATO Document AC/139-D/7. These alternatives fell into three categories.

(1) The prime contractor to be selected from one of the partcipating national firms;

(2) Create a working association, one with only a shell company jointly owned by the leading national firms;

(3) Create a joint firm for the purpose of the project, formed under either the laws of one of the participating nations or by treaty within a supranational framework.[32]

An alternative emanating from the other side of the Atlantic had also been offered and been rapidly dispensed with in 1958 prior to the Industrial Conference. Raytheon proposed the creation of a consortium of European companies under its leadership, which would negotiate with the 5 PG's or NATO for the production. This would have made the European firms, selected and approved, beholden to Raytheon instead of their governments. Though rejected this time around, a similar solution was eventually adopted for the follow-on Improved Hawk program known as HELIP, in the 70's.[33]

The option of naming one national prime contractor (NPC) to act as well as the European prime contractor (EPC) would have had the advantage of efficiency and simplicity. However, with the necessity of imparting systems know-how to all participants, the EPC would have to admit engineers from the other NPC's into the EPC's existing organization. In such a project this would have presented serious problems among competing firms. Other serious handicaps would have been: the difficulty of making a choice of a single firm acceptable to all five NPC's; the leverage this firm would have vis-a-vis NPC's and the intergovernmental agency for current and follow up operations; the need for the selected NPC to undertake difficult contractual, legal and financial negotiations and responsibilities with foreign governments while representing those nations' own firms.

The concept of a consortium was rejected due to its suitability being limited to projects where tasks can be clearly defined and divided up from the beginning.

It is not at all suitable for a system-type undertaking with the degree of uncertainty inherent in modern weapon systems. Also legal and financial problems

of then-conflicting national laws rendered this solution impossible, for there had to be a firm which could be held legally responsible by each government.

The remaining option is that of an internationally owned company. While the possibility of a company created under international treaty intrigued the conference, it was deemed impractical due to time constraints.

Therefore, the Industrial Conference recommended that the participating companies form a jointly-owned corporation under the laws of one of the PG's that

would contract with either a multinational agency or each of the 5 PG's. Since France was at that time the largest participant in the program, the company was organized under French law and located in Paris.[34]

d. SETEL Is Set Up

Bargaining and maneuvering had been intense while the Industrial Conference was in session from early December 1958 to mid-January 1959. But the 5 NPC's were able to reach speedy agreement. This was in good part a result of the really major decision at the beginning—financial reparation of production— having already been reached by the 5 PG's through the NATO Hawk Working Group. This was further assisted by the fact that France and the FRG had the two largest orders and in this period the FRG's Government and its industry were still bending over backwards to be conciliatory.

In addition to the establishment of a jointly owned European Prime Contractor (EPC) under French law, other aspects of the recommended organization were:

- An existing firm would be selected to assist the EPC in systems engineering and coordination, in order to avoid the time-consuming process of building up a large and complex organization. This firm would be given a mission contract (mandate) by the EPC. CFTH was selected for the task and received a separate contract for this purpose.

- The five NPC's would actually carry out the production, being bound contractually to the EPC.

- The EPC's BOD (to be known as the Conseil) would have one representative from each NPC and formulate top policy.[35] Policy would be executed by the EPC headquarters organization, headed by a managing director, appointed by the BOD upon proposal of the French NPC. Several specialized assistants from the 5 NPC's would complete the EPC's management team.

- CFTH agreed to accept engineers from the other NPC's for work in the Mandate.

The EPC, established in Paris in June, 1959, was named Societe Europeene de Teleguidage (SETEL).

In contrast to the NATO Atlantic Maritime Patrol aircraft project, where the original thrust came from NATO, and NATO was more actively involved in the selecting of participants and the creating of the ground rules for industry, here with Hawk, the NPC's were allowed a freer hand in setting up their own organization.

One of the outcomes of this greater freedom for the NATO Hawk project was that no one firm was given the lead role in managing the joint firm, as had been with SECBAT for the NATO Atlantic project. Of course, the choice was not nearly as straightforward as the Atlantic case either, where one nation's order share was predominant and one of the participating firms had designed the system (here too though at the expense of wider participation).

4. SETEL and the Evolution of the Government-Industry Relationship in the Management of the Program

a. The Government-Industry Balance of Management Responsibilities

The original intention was that the focal point for the management of the NATO Hawk program was to be at the industrial level, not the governmental level. Although on the one hand, SETEL proved to be an effective spokesman for each of the 5 NPC's while also looking after their financial interests, individually and collectively, on the other hand, with regards to its primary function as system manager for the industrial effort (i.e., disciplining the firms so as to produce the Hawk Batteries on schedule within budget estimates), SETEL had serious difficulties. As a result of these difficulties, and several other key factors that will be brought out shortly, the intended balance between government and industry in the management of the program, shifted from one initially heavily weighted toward industry, to one weighted toward government.

Again, as with the NADGE project which finally got underway some six years later, the original assumptions vis-a-vis program management proved to be inadequate.

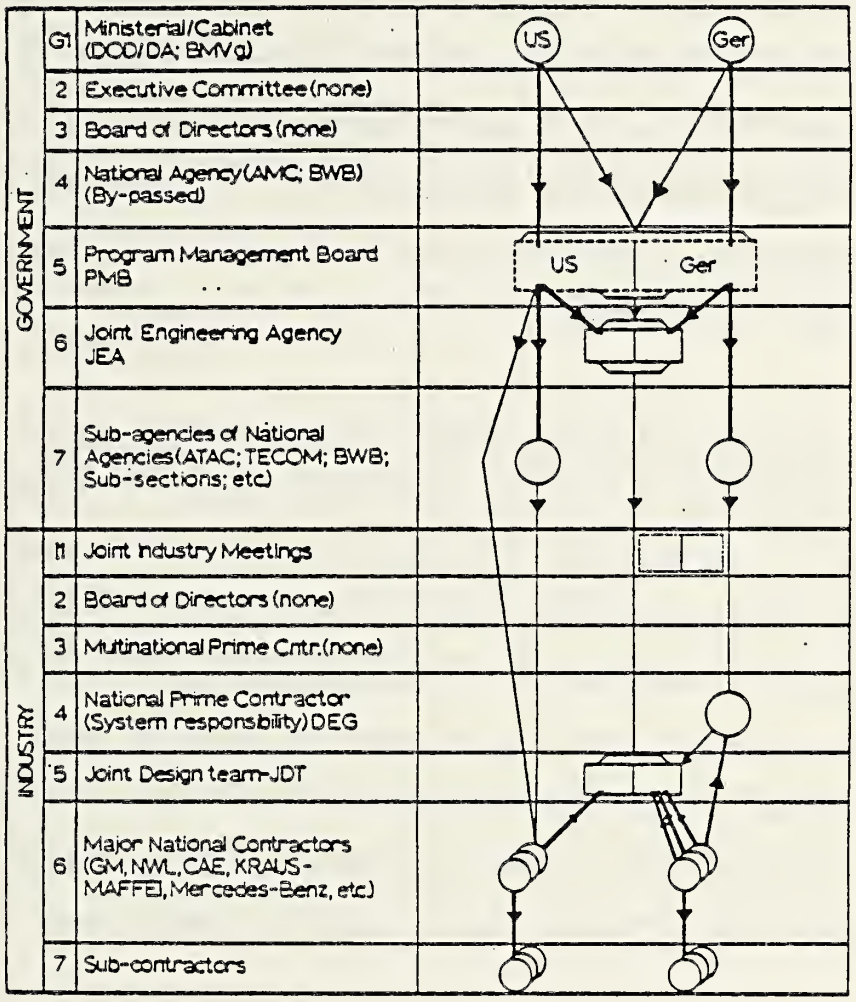


Figure 5. *MBT-70 Organizational Structure.*

SOURCE: M. S. HOCHMUTH

Only for NADGE it was the host government - NATO Project Management Organization relationship which evolved along lines quite different from those originally planned. These projects exemplify once again a key characteristic of collaboration for defense procurement at the transnational level. Granted that the NATO Hawk program represents an early stage in the phenomenon, in contrast to the defense procurement environment at the national level, here we see a business-government relationship marked by amorphousness and fluidity, while still involving the standard set of problems peculiar to defense contracting (e.g. interdependence, highly politicized, uncertainty and vulnerability to disruption and major cost increases).

b. The National Prime Contractors' (NPC's) Approach to Utilization of SETEL

Having asked the NPC's to come up with an industrial management structure before determining the governmental management structure, the Hawk Working Group, AC/139, tacitly acknowledged from the very beginning that the program would be basically an industrial one. It was accepted that no one industry could be solely responsible, yet each PG wanted an industrial entity that could be held responsible for delivering the entire system. The Industrial Conference report HK42 did describe a legal entity competent to contract, and one vested with what appeared to be sufficient central authority, and the means of exercising it.

Although the freedom allowed industry in setting up its own organization and procedures resulted in inadequate industrial management and slow program implementation, this may also have been unavoidable due to the lack of enthusiasm shown by several of the NPC's in the beginning. Urged to enter the project by their respective governments, these reluctant NPC's would have been much less

prone to cooperate had the intergovernmental body attempted to impose the ground rules on them. These firms, as previously mentioned, were competitors in the EEC, and unlike their governments did not have a commonality of interests. On top of this, these firms had had limited previous experience in large-scale contracts for such "uncertain" weapon systems. These factors led to a prolonged foot-dragging as the firms gradually accustomed themselves to working together, to the Hawk system and the complexities of negotiating with the NHMO.

Hochmuth perceived the NPC's as facing a choice of three possibilities in how they would use the EPC-SETEL:

(1) use it as a post office box, and a place to meet and reach decisions;

(2) retain decision making authority in the BOD but use SETEL as an active problem solving center generating possible solutions for approval;

(3) create a truly strong organization that could actually direct the industrial side of the project, and negotiate with full powers with the governmental side.[36]

Seriously underestimating the complexity of the task, originally wary of each other, neglecting the systems evolving nature, and assuming that the program could be portioned out to the 5 NPC's in well defined production packages, they picked the first option—that of the post office box. This was to have the effect of placing them on the range possible approaches, back close to the Shell Company option previously eschewed.

Decisions were made at each NPC and then were harmonized at the meetings of SETEL's Conseil. Of course, in the initial stages, home office coordination had to be dealt with before the project could take off. In the most crucial area of all, however, production planning, where a tightly coordinated centrally directed effort was required, the least was accomplished. In any case, the 5 NPC's did belatedly recognize the need for a stronger SETEL to bring them all into line for a coordinated effort. Agreements were eventually reached and SETEL's authority and staff were somewhat strengthened, but not before damage had been done.[37]

SETEL Staff Statistics

Number of Personnel by Nationalities (July 1964)

Belgium	16
France	61
Germany	16
Holland	8
Italy	16
USA	1
United Kingdom	5
Canada	1
	124

Summary by functional levels

Professional personnel	58
Technicians, clerks, service personnel	66
	124

Source: Cornell

c. The Five Participating Governments' (PG's) Objectives

The technological aims of the 5 PG's themselves were not directed toward integration. Quite the contrary. Each PG saw the Hawk program as a necessary

step towards insuring the competitiveness of its own national industry.[38] Each had, as such, already entered into an implied contract with the NPC it had selected to serve as the instrument for retention and exercise of the new technology on behalf of the nation.

> In return this obligated each government to champion its firm when necessary, and thus were created 5 purely national if informal partnerships. Given the "Chinese copy" concept of the task, there was no need to press for a central strategy. When the 5 firms sat down to draft HK42, theirs was more of a "shotgun marriage" than a voluntary union to achieve commonly held goals. The firms were led to the altar by their governments, and SETEL was created to meet the juridical and the communication requirements of this marriage.39

Add to the above considerations the fact that the program was contracted on a cost plus percentage of cost basis, while three of the NPC's suffered from limited capacity, while facing more profitable commercial business opportunities elsewhere due to the growing boom in the European economies, and it's no surprise that SETEL failed to provide strong program management.

As such, when the PG's chose the government management structure to match the seemingly adequate industrial structure proposed by HK42, there was no intent or perceived need to create a supranational agency with wide powers. What was wanted was an agency that could serve as a "watchdog" for the PG's vis-a-vis the collective industrial effort, as well as a secretariat to the BOD and an executive agent of its collective will. However, as we've already seen "when the government chose a strong, skillful, forceful General Manager from a small country who built his power through a carefully guarded neutrality and who assembled a competent team, they set the stage for de facto transfer of their power to Reijnierse."[40] Angles d'Auriac once said: "My client was Reijnierse."[41]

When Reijnierse, having assumed the role of customer, tried to get a price, a cost, a commitment or even an argument, he could not negotiate with his apparent counterpart. For this actual counterpart was not the SETEL General Manager, but the SETEL Conseil. The SETEL General Manager became... "in effect a liaison agent and interpreter between the NHMO general manager, Reijnierse, and the Conseil."[42]

It is worth once again recalling at this point, the case of NADGE where the situation developed along almost opposite lines. At the industrial level NADGECO and its President were able to assume the position of a stronger central management authority than might have been expected for the consortium of 6 firms. In the case of NADGECO, though one firm, Hughes, with its 35% share, was the acknowledged leader of the inter-firm company. NADGEMO, at the inter-governmental level, on the other hand was unable to provide the centralized authority originally expected of it, instead falling into the role of somewhat of a liaison agent between the nine host governments and NADGECO (the original concept of the NHMO's role).

d. A Comparison of General Manager - BOD Relationships of SETEL and the NHMO

With NATO Hawk, the disparate views of the NPC's, and their initial attitude that each could operate relatively autonomously of the others, led to an entirely different working relationship between the SETEL General Manager and the 5 NPC's (through the Conseil), than that which developed between the NHMO's General Manager and the 5 PG's.

This difference in industrial and governmental approaches to program management manifested itself almost immediately in the staffing of SETEL and the NHMO. HK42 defined SETEL's responsibilities as "centralized planning, central technical management and coordination or coproduction," and "coordination of economic and financial matters."

> But the actions of SETEL's board of directors (the Conseil) made it clear that the 5 NPC's regarded the program as a pure production effort requiring little more of SETEL than to carry out instructions and to serve as a distribution center for know-how emanating from the United States. It is therefore not surprising that Angles d'Auriac had considerable difficulty in getting good people assigned. Only his own firm, CFTH, could really be counted on to support him.43

The other NPC's not only did not view SETEL as a strategy center but had little talent to spare. Moreover, there was the concern among middle managers and young executives that assignment to SETEL would take them out of the mainstream in their companies and cost them future promotions. In spite of this SETEL was able to get some good people assigned from the non-French NPC's. Yet, the point remains, the SETEL General Manager, Angles d'Auriac, still had almost no control over whom he got for his staff.

As already seen, Reijnierse had greater success in this regard. This was partially due to his own efforts, but he was also assisted by the military's always having considered an assignment to joint or multinational agencies as a positive factor vis-a-vis future promotion, as long as one didn't stay too long.

Quoting from Hochmuth, an early member of the BOD summed the situation up nicely:

> The NHMO was a genuine transnational office. NHMO people had to forget they carried national identification cards. On the other hand in SETEL they had to lay theirs on the table in front of them so they couldn't forget it. This meant that SETEL's important decisions were made jointly and unanimously at a level where the impact of such decisions on the NPC's were intimately known. That level was the Conseil.44

As the NATO Hawk Production Organization's BOD gradually came to meet less frequently over time, the SETEL Conseil still met at least every month. The frequency of the Conseil's meeting indicates the fact that SETEL did not have amongst its functions the role of preparing decisions for adoption by the Conseil between each session. Although the bylaws had provided for weighted voting, no one firm was ever voted down in the 90 meetings that took place in the first 86 months of SETEL's existence—i.e., the rule of unanimity prevailed.

> The NPC's insisted on being heard at every opportunity. They formed an Industrial and Technical Committee and a Finance and Administrative Committee made up of their top full-time Hawk managers. These committees met frequently at SETEL and strongly influenced Conseil members.45

The creation of powerful committees of senior company executives outside of SETEL Headquarters to assist the Conseil in strategy formulation left Angles d'Auriac with almost no possibility of asserting leadership.

In drawing on the experience of the NHMO and several other transnational organizations Hochmuth came to the following conclusions:

> Creation of an appropriate structure outweighs in importance cross-cultural and interpersonal problems. .... The research points up the secondary importance of language differences and different national "ways of doing things".46

> On Reijnierse's staff a serious personality conflict arose between 2 key officials of different nationality. Reijnierse's structural authority gave him the power not only to prevent this conflict from paralyzing or perhaps even wrecking the organization but to use the

conflict constructively in building his power base and channeling the energies for the common good of the organization. Reijnierse controlled the reward system and could allocate responsibilities.47

To achieve the desired results of an integrated multinational team, particular care must be given to reducing, but not eliminating, the informal ties between team members and their home organizations. Such ties are vital to the transnational management agency because they provide direct informal information and communication channels between the agency's leadership and each participant. Such communication links were most effectively used by Reijnierse in the HAWK program. But unless the team members' loyalties are oriented towards the transnational agency and its chief, the benefits are completely overshadowed by the disruptive forces which seem to surface as cross-cultural and interpersonal problems48.

In designing a transnational organization the term structure must be taken in its complete sense. Particularly important are the reward and information systems and formal organization that avoid the stamp of national dominance or favoritism.

The chief executive should have wide choice in the selection of his staff and he should be an integral part of his staff's reward system. Not only should the leader be able to hire, promote, and fire staff, but his recommendations should carry weight when a "transnational employee" or an "international civil servant" returns to his own firm or government.49

No less important is the deliberate selection of a leader with adequate "initial power capitalization" who can create an "institutionalized" team and therby exercise a meaningful strategy.50

e. Distinguishing Between SETEL and 'La Grande SETEL'

In attempting to explain the difficulties and misunderstandings that arose between SETEL and the NHMO, M. G. Wenisch, head of the NHMO's technical division, attributed them to a distinction developed at some length by Angles d'Auriac, General Manager of SETEL.

The 5 PG's having decided from the beginning that SETEL would be the entity responsible for delivery of the system, failed to distinguish between SETEL 'stricto sensu,' and SETEL 'lato sensu', or what Angles d'Auriac had termed La Grande SETEL (i.e., SETEL, the Mandate, and the 5 NPC's). According to Wenisch it was this absence of an entity of the stature desired by the 5 PG's that poisoned the relations between SETEL and the 5 PG's and made the life of SETEL's central office very difficult. Crushed between the demands of its masters and clients,

> SETEL could serve as no more than an amplifier in both directions: attempting to pursuade the NHMO to act in accordance with the desires of the NPC's (and often the most demanding among them) or attempting to convince the NPC's of the merits of the demands of the 5 PG's.51

As emphasized by Angles d'Auriac,

> ...even though it was SETEL that was legally responsible,...only La Grande SETEL could deliver. Despite the statements in the Final Report of the Industrial Conference (HK42) SETEL could not be—at least to begin with—a true firm. There could be nothing more when we started ...than a simple Arbeitsgemeinshaft (consortium) working under the rules of voluntary participation and defining its policy case by case.52
>
> Actually, SETEL could not claim, and especially couldn't claim during the first years of its existence, to be a firm having its own truly independent will and pursuing its own objectives.53

SETEL's General Manager, Angles d'Auriac, preferred to emphasize the reasonableness of this approach, all things considered. After pointing out that a leap to an entirely integrationist solution was not desirable or even realizable in 1959, he stressed the necessity of keeping in mind that nations do exist and are suspicious of any encroaching central authority.

Moreover this industrial authority would be one only recently established and without a past, while exercising control over more than 100 firms located in five countries. This new authority, even if everything possible was done to give it a European face, would be fatally marked, be it only for practical and geographic reasons, by certain national traits (in this case French). Therefore a system of pyramidal control was the one followed for the Hawk project. The apportioning and coordinating authority, SETEL, exercized its control over the producing firms through the 5 NPC's, each having at its disposal all that was necessary for

exercising such control in its own country: i.e., knowledge of national industrial and technical capabilities, well established relationships of long standing, and especially the status enjoyed by each NPC within its own country.

Focusing on one major benefit of this pyramidal form that SETEL assumed, Angles d'Auriac pointed to a situation that still existed as of April 1964—numerous contracts between the NPC's and their subs were still nonexistent. This lack of legal instruments had not delayed the program in any way whatsoever. This alliance of five major national firms within SETEL gave the subcontractors a moral, but very real, assurance that permitted them to engage in production without the covering of contractual instruments that they would normally require.

f. Two types of Enterprise

In an attempt to explain the quandry in which SETEL found itself, Angles d'Auriac, in a speech quoted from Hochmuth's Organizing the Transnational, distinguished between the kind of enterprise spelled with a lower case "e" and one with a capital "E".

SETEL he explained was an ad hoc enterprise—spelled with an "e"—one created solely to facilitate production of the Hawk system.

> And when we tried to convert it into an Enterprise—with a capital "E"—we ran into all sorts of difficulties.
>
> In an enterprise all the difficulties can be accepted and dealt with on a case by case basis, and no partner has to abdicate his company's sovereignty. There may be agreement, there is absolutely no permanent transfer of authority, no managerial concentration, no merger. But as soon as one tries to create an all-purpose alliance, as soon as you want an Enterprise with a capital "E", whose goal is not precisely

> defined in detail, then all the difficulties that you have successfully been able to avoid or overcome on a case by case basis reappear, and it is certainly difficult to pass from the stage of an inter-firm entente to the stage of an Enterprise that is truly unified, with a general agreement concerning a whole area of business, even a limited one.
>
> It was very very difficult to transform a 'pleasant affair' of seven years into a lasting marriage. Many difficulties appeared. A whole series of problems of political, commercial, and legal nature that we had been able to avoid reappeared with a vengeance.54

SETEL was not in the best of positions. Pressed from one side by Reijnierse, who wanted an industrial counterpart with an equivalent authority; pressed from another side by the NPC's through the Conseil, which had no intention of surrendering to Angles d'Auriac any more than the minimum of authority necessary (he would have been capable of diverting NPC resources from other more profitable products and markets) while acccusing him of failing to win his arguments with Reinjierse; and being pressed from a third side by the NPC's, but this time in their role of SETEL subcontractors, with their set of problems and delays—Angles d'Auriac found himself squeezed into a corner.

> Angles d'Auriac tried to shed his company affiliation and to appear neutral in the eyes of the Conseil. But he was never really successful. For one thing, he was unable to create a unified whole out of the Conseil. He therefore had to build a narrow power base with his old boss, Laveran, the CFTH chairman of the Conseil. A knowledgeable observer stated that when Angles d'Auriac needed help, he invariably called on Laveran to help plead his case in the Conseil.55
>
> From the NPC's point of view, SETEL came more and more to be considered a French organization rather than a multinational one if for no other reason than the Mandate was French and despite strong efforts on the part of Angles d'Auriac to organize SETEL so that he could put non-Frenchmen in key positions.56

Faced with the dilemna of having the responsibility, but not the authority, more often than not Angles d'Auriac had to resort to the technique of letting

the situation ripen until the solution became obvious. His strength was giving the Conseil nothing to decide, getting decisions by nibbling away and presenting 'faits accomplis.'

SETEL was not altogether ineffective, however. With regards to control coordination, parts procurement, and production control responsibilities, SETEL performed essential functions. But its slowness of response to even routine problems led to the shifting of many of its responsibilities to the system's engineering organization (known as the Mandate), by default. Consequently, the latter's strength relative to SETEL continued to grow, while the Mandate came to work more and more closely with the NHMO. "As events moved in on them, the NPC's were forced from their initial go-it-alone attitudes, but only bit by bit did they look to SETEL and the Mandate and surrender freedom of action."[57]

The terminology alone, selected to designate the five principal national industrial actors tells much about intentions. The term 'National Prime Contractor' (NPC) adopted for the partners of this enterprise with a lower case "e", can be contrasted with that used for their counterparts in the MRCA Tornado project. The partner firms of Panavia, an Enterprise with a capital "E", were designated national main subcontractors.

Whatever the merits of the individual parent firms lines of reasoning for not letting SETEL become an Enterprise with a capital "E", as pointed out by Hochmuth, the long range result was that the krow-how transferred had evaporated from all but the French national prime contractor (NPC). Thomson-

CSF effectively used it to develop the Crotale close-in air defense weapon system.

5. Negotiation of Licensing and Technical Assistance Agreements

As has been previously mentioned the U.S. Government had agreed to provide a license to the 5 PG's for its proprietary rights relating to Hawk, waiving all reimbursement. But there were still background proprietary rights and know-how that the U.S. Government could not provide. So it was necessary for the American contractors to enter into licensing and technical assistance agreements with SETEL.

As always with licensed production, the NPC's and their subcontractors would be needing technical assistance, and the cost of providing these engineers would be paid as incurred. However, the fee for the intangible know-how and proprietary rights was highly negotiable. Consequently, Reijnierse intervened and took charge. Even though the negotiations and the resultant contracts were between Raytheon and SETEL, Reijnierse took it upon himself to ensure that these costs, to be footed ultimately by the 5 PG's, were kept to a minimum.

Raytheon had insisted from the earliest negotiations that it expected to receive "fair compensation" for its rights and know-how. Raytheon was asking for more than $25 million. The negotiations were stalemated, and SETEL and the NHMO protested Reijnierse got the U.S. Government to intervene in order to break the impasse. As a result of the following negotiations a license fee of

only $7 million was agreed upon. The agreement was signed on September 30, 1960 (and later a rider for prolongation on July 1, 1963). A similar agreement was signed between SETEL and the Aerojet Corporation on October 24, 1960, the U.S. producer of the missile rocket motor that had opted for dealing directly with SETEL.[58]

Another factor complicating these negotiations were the differing views of the NPC's concerning their requirements for technical assistance. On the one hand several of the NPC's were reluctant to have skilled Raytheon engineers observing their business at close range while others wanted all the assistance they could get, especially since it was a cost-plus program to begin with. In addition the 5 PG's generally provided the direct cost surveillance function vis-a-vis their national industries (treated elsewhere in this paper), but over the use of technical assistance it was the NHMO that assumed this watchdog role, ensuring that no additional requirements beyond the contracted amount would be requested. While the watchdog procedure is normal in U.S. cost-plus contracts, the European NPC's and SETEL perceived NHMO scrutiny and questioning of NPC requirements as an unnecessary infringement on industry's rights.[59]

6. The Transfer of Data and Configuration Control

a. Data Transfer

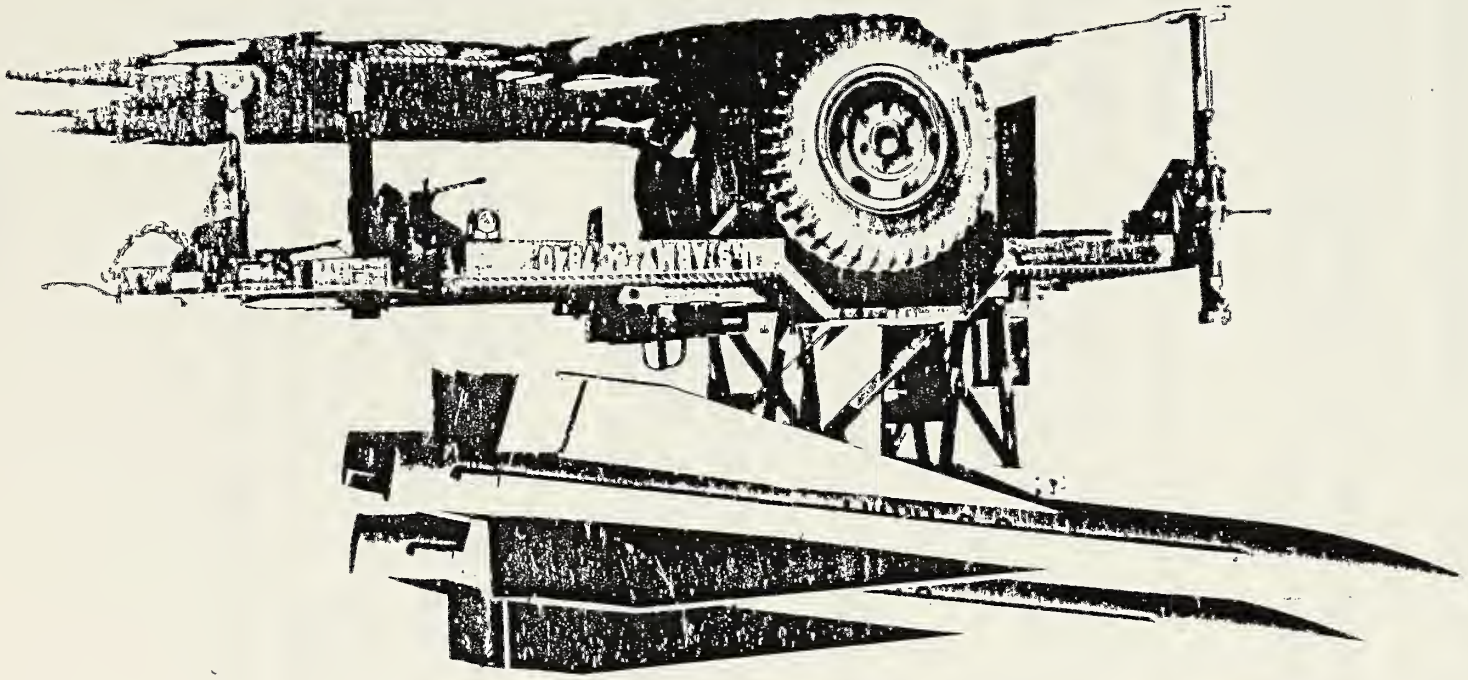
In order to handle the task of transfer and control of over 5 million drawings, specifications and technical instructions, two documentation centers were established; one at the Raytheon plant in Andover, Massachusetts and the

other called the Mandate at Bagneux, near Paris. The Andover center put all documents on microfilm, mounted on IBM cards, which were then sent to the Mandate where they were reprinted, accounted for and shipped to all participants. Some reproductions from the microfilm were not sufficiently legible but this is somewhat understandable when the size of the task is considered. In any case, Sepia was eventually used, solving this problem.

According to A. H. Cornell, "the NATO Hawk documentation system performed well with regards to shipping costs, storage, and ease of reproduction, and ... above all, the system afforded simplified control over the mass of classified matter and succeeded in maintaining strict security during the critical period of initial distribution."[60] However, Angles d'Auriac's (General Manager of SETEL) assessment would tend to qualify this evaluation. According to him the poor quality of the documentation received resulted in a considerable amount of work, at the beginning of the program, to put it all in order. The European's not only didn't receive the data package from the U.S. on schedule, but when it did arrive it came as a disordered flood of documents and designs. Angles d'Auriac claimed that this had important repercussions on the start up of production.[61]

b. The Systems Engineering Organization - The Mandate

A unique characteristic of the NATO Hawk program was the organization, responsibility and scope of the separate systems engineering organization, the Mandate. Later this organization was enlarged and renamed the Technical and Documentation Center. HK42 stated that CFTH received its mandate from SETEL "to assume Central Technical Management and Coordination of production, i.e.,



coordination of liaison with U.S. industry; coordination of documentation; and establishment of modification procedures." As is often the case, however, the word coordination implies the role of a sort of "catalyst", that does not have the authority to discipline the others in the organization or process.

The Mandate was a separate, but subsidiary body of SETEL, originally created as a documentation center. It was staffed principally by, and located within

Compagnie Francaise Thomson-Houston (CFTH), the French National Prime Contractor (NPC). As a technical group, its services were obtained by the NHMO by contract with CFTH. At the peak of its activity the Mandate had 530 employees. Of these, the number that were non-French never exceeded 20. As of 1965, the cost of operating the Mandate had come to around 5% of total program expenses. The Mandate was originally charged with:

(1) acceptance procedures and registration of European modifications to Hawk;
(2) coordination of all documents destined to operators of the program, and;
(3) coordination of parts lists for maintenance.

However, as its original documentation functions continued to expand, it was eventually redesignated the NATO-Hawk Technical and Documentation Center (NHTDC) in 1963, when logistics and certain other technical support functions were delegated to it. After this period of expansion, the NHTDC was to provide centralized services as follows:

(1) Technical evaluation of Unsatisfactory Improvement Reports and Contract Field Technician Reports.

(2) Electronic Data Processing System operations of documentation for the European dossier for such things as: maintenance; storage lists; inventory control listings; certain repair parts; maintenance of NATO-Hawk Manuals and item identification lists; statistical analysis of NATO-Hawk firings; and manufacturer's lists.

(3) Technical studies for modification programs and the modification kit pilot phase (approved modification sets being the attempted means of controlling the configuration problem).

(4) Printing operations for technical publications and changes; Monthly Information Bulletin; and NATO-Hawk Modification Work Orders.

> Hence the Mandate became the technical nerve center for the program. It grew in size, scope and technical authority. It produced rules, regulations and procedures for configuration definition and developed controls that were essential to the progress achieved by the NATO Hawk Production Organization.62

There were several reasons behind the choosing of the Mandate, as the entity which would evolve into the de facto system engineering organization. Had the NHMO been burdened with performance of the tasks of system engineer, it was felt that this would have interferred with its primary job of management. Had Raytheon performed this function in Europe, with an American staff, this would have meant the transfer of less technical know-how to the participating nations, such transfer being a major purpose of the program. Also, one of the major

reasons for placing the Mandate with CFTH in the first place, still applied; CFTH was the only NPC that had an excess of the technical personnel required.

c. Configuration Control

The NPC's originally considered the Mandate as a low level technical service organization, serving essentially as a data-distribution center, and with technical responsibilities clearly remaining with the five NPC's. Their reasoning being that they were expected to produce an exact copy of the U.S. Hawk system which had already been engineered into a system in the U.S. No need was foreseen for centrally located experts with overall systems knowledge, since each NPC would get the proven data that it needed to manufacture and test a major part of the system.[63]

> Consequently, it is apparent that the Mandate was not originally intended to be as strong an organization as it eventually became. But the European industrialists had failed to anticipate the work the Mandate would have to do to secure and maintain the technical definition essential to their efforts. Nor did they realize that system configuration definition and control is necessarily a centralized, authoritative function essential to the production of any modern weapon system.64

However, as we'll shortly see, the responsibility for this lack of appreciation of the scope of the tasks the Mandate would have to perform, did not rest solely on the Europeans.

It was originally understood that the European produced version, the NATO Hawk, would be a "Chinese copy" of the U.S. Hawk. However, as the drawings and specifications began to flow into the European factories in early 1960, it soon became obvious that they did not match the sample equipment previously provided from the U.S. By September it had become glaringly serious. The

reason being that the system was developing so rapidly that drawings were in some cases months out of date. The NPC's had looked forward to assembling a clean, tested production package, but now, for example, there was no assurance that the launcher to be built in Belgium would match the missiles built in Italy using revised data.[65]

This problem dates back to the Working Groups visit to the U.S. in 1958. At this time the go-ahead for production of the Hawk in the U.S. had just been given, with no units in the field yet equipped with it. The Working Group saw demonstrations of the system and received glowing descriptions of it by both the Army and Raytheon, both obviously anxious to sell.

> What was most impressive were the busy production lines from which equipment was steadily being shipped. The impression given the Working Group was that they were seeing the latest in advanced technology, proven and in production. None of the Europeans then really understood the nature of such modern systems—almost permanently unfinished and in constant technical flux. Normally such systems fail to meet desired performance early in the production phase and go through numerous crash programs to find and fix the problems.66

Eventually, three steps were taken to establish better configuration control for the program:

(1) A set of major equipments of latest design and for which Raytheon had adequate documentation, was selected as the basic Hawk configuration to be produced in Europe. In effect this design was frozen for European production, so that all future changes could be controlled in Europe.

(2) Europeans obtained and validated a complete set of technical documents and sample hardware for this system configuration. This set was known as the "European dossier".

(3) Europeans devised and adopted a set of rules and procedures to control changes, to be made in technical documents used and hardware produced in Europe.

Starting in the fall of 1960 the Mandate spent three years developing and improving configuration definition and control procedures based on two categories of interchangeability with the U.S. produced Hawk:

(1) Complete conformity—an exact replica of a U.S. produced item, produced in Europe by a process identical with that of the U.S.

(2) Industrial interchangeability—identical in form and function with a U.S. produced item, but processed differently.

Thus by late 1963, the scope and authority of the Mandate as "system engineer" had been greatly expanded. It had become a system engineering organization as well as a technical staff agency.

As technical decisions continued to be made in the U.S., the Europeans were notified as they were authorized. For these changes, initiated in the U.S., the Europeans assumed control over the rate of adoption on their side of the

Atlantic. These procedures resulted in minor deviations between the U.S. and NATO Hawk systems, varying by an amount corresponding to 2% of all the parts of the system by December 31, 1966. This variation continued to increase through the end of production the following year.

American and European officials expressed the opinion that the Mandate had performed so satisfactorily that many aspects of its configuration control procedures were worthy of adoption in U.S. weapon system programs. In addition, the Mandate's thorough documentation of the entire program was to prove to be extremely valuable for the HELIP follow-on program for the Improved Hawk.

7. The Production of the NATO Hawk System

It is important to note that, in spite of the protracted nature of the negotiations over certain legalistic aspects of the program, they in no way slowed the launching of the industrial effort. In other words, one could say that, even if the form assumed by the structure within which the program functioned was only able to conform to the desires of the governments after considerable effort had been expended, actual production on the other hand received a great deal of attention from industry early on. The production delays suffered by the program were due to other causes and will be touched upon shortly.

a. Distribution of Work

But first of all, the program's nature required a delicate balance between national and total project considerations in the distribution of production. The maintenance of a minimum of duplication and a maximum use of existing facilities

had to be reconciled with each country's production allocation being in proportion to its share of the total order, while still allowing each nation to receive all the know-how. A degree of duplication of manufacturing and assembly, therefore, was inevitable. And so as to insure that each nation got its fair share of technical know-how, production was allocated in such a way that each nation's share would be roughly 65% electronic and 35% mechanical reflecting the total system ratios. At the level of major subsystems this meant, for example:

- the production of engines was carried out by two identical production lines: one in France, and one in and Italy;

- radar and guidance components were manufactured by two production lines controlled by three nations;

- the launchers were assembled in two production lines.

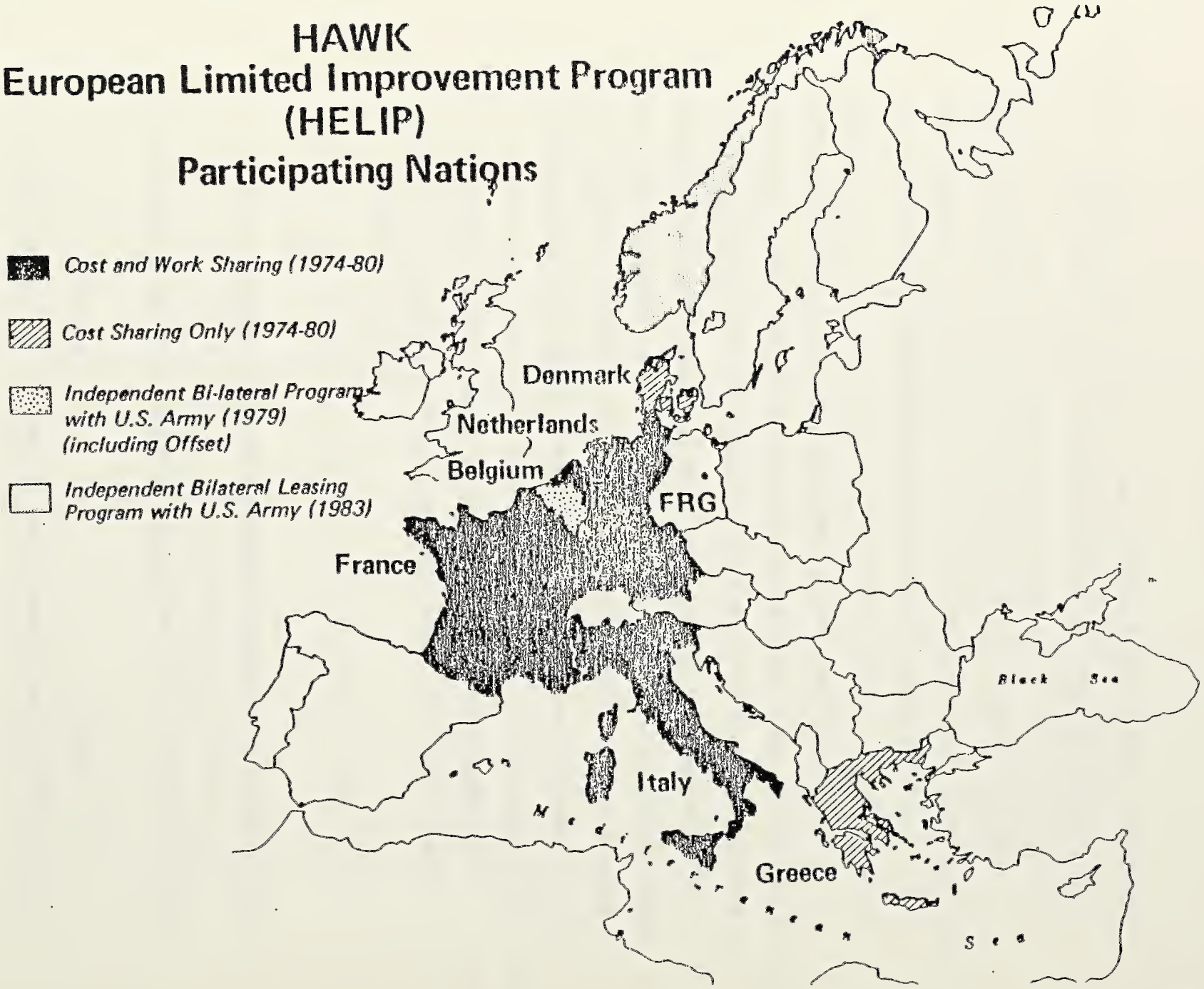
Final assembly was accomplished under SETEL at two locations in Italy and France at its HAMCO centers. The Hawk assembly system check-out center (HASCO) was set up in Italy, and the test firing was carried out in Algeria and Sardinia. NHMO controlled the distribution of the assembled systems.

Problems that arose in the allocation of work included:

- the five firms being commercial competitors;

- preference for work on key components;

HAWK
European Limited Improvement Program
(HELIP)
Participating Nations



- the greater prestige associated with assembly and the manufacture of certain components;

- the desire to acquire as much knowledge as possible about the missile;

- the actual capabilities of the national industries to produce a given component.

b. The Technical Slices

As is common in licensing, production was planned in terms of a series of runs, or technical slices, numbering five in this case and designated A, B, C, D, and E. Each succeeding run involved a greater amount of European manufactured items, and fewer U.S. manufactured items. Such a system of technical slices enabled the program to get started as quickly as possible while giving sufficient time for the NPC's to tool up and develop a maximum number of qualified European suppliers. It also enabled the Mandate, SETEL, and the NHMO time to gain their own know-how, and (as an unexpected benefit in the case of NATO Hawk), to deal with such complex problems as that of concurrency (i.e. the simultaneous development and improvement efforts of the Hawk designs during production).

c. Some Production Problems

The major problems encountered during production of the Hawk in Europe, can be attributed to:

- The original lack of an appreciation for the evolving nature of the system's design, and the uncoordinated shipment of data from the U.S.;

- The slowness of procurement of parts from the U.S., through the U.S. Army supply procedures;

- The quality of parts received from the U.S. caused difficulties - quality was sometimes insufficient, but more importantly, there was often a significant gap between performance and specifications.[67]

- the NHMO's forcing of an overly optimistic production plan on SETEL;

- The inadequacy of production planning vis-a-vis timeliness, assumption of responsibility by the five NPC's, and monitoring of the program.

Those production problems stemming from the shipment of documentation and the system's being under continual development have already been treated in the previous section. Although the persistent and rapid evolution of the system variously affected all the different elements of the system, one element in particular was singled out as especially problematic. According to Angles d'Auriac, the substitution of a high powered illuminator radar for the original radar, profoundly transformed the program, and constituted a determinant factor in the delay.[68] Other problem areas included the target ranging radar, and field maintenance equipment.

d. Parts Procurement in the US for the First and Second Technical Slices

Parts for the first production run, the A series, were ordered through the U.S. government from Raytheon in subassembly blocs (i.e. all missile parts as one bloc, all illuminator radar parts in one bloc, etc.). Beginning with the second

technical slice, the NPC's had to make make/buy decisions on a part-by-part basis, having to decide which parts would be ordered through the U.S. government, and which parts would be manufactured in Europe. But, it was not until October, 1961, that SETEL furnished to NHMO the NPC's lists lists of parts and materials that would have to be procurred in the U.S. for the series B production run because of the problems with the documentation and evolution of the system's design.

> What NHMO had not considered was that the procurement of parts and supplies for a production program through routine U.S. Army supply procedures geared to repair-parts procurement could be the penultimate
>
> in cumbersome administration. NHMO saw only the great advantage of normal U.S. Army procurement policy aimed at obtaining the lowest prices. Naturally the NPC's and SETEL resisted this system of procurement, but to no avail. They found themselves under pressure from NHMO to lay out a tight production schedule, on the one hand, but, on the other they had no control over the essential delivery of materials!69

Nevertheless, a short-cut procedure was eventually worked out whereby, with the approval of the NHMO, the European manufacturers could go directly to the U.S. manufacturers.

As delivery of the first A series batteries neared in June, 1963, the total program was running about 15 months behind schedule, at least with regards to optimistic Plan No. 7. Of this 15-month delay, it is estimated that documentation and design stability problems accounted for a delay of around nine months or so, with the cumbersome parts procurement adding another six months.

e. Production Planning

Control of production planning proved to be another serious weak point in the NATO Hawk program. Some production planning had been going on since the Working Group discussions in 1958. The program, however, suffered from a long and costly start up time. It took about four years for the first Hawk battery to be delivered to the military forces. All parties concerned were clearly overly optimistic about the time and cost involved in getting the production effort underway.

Production planning began in earnest after a training and indoctrination trip by the NPC's and SETEL to Raytheon in the fall of 1959. The resulting plan, Plan No. 7, was published in February, 1960. The plan, however, under pressure from NHMO, was the most accelerated possible, providing for delivery of batteries one year sooner than previous plans, and for a six-month speed up in missile delivery.

Though the production contracts had invested SETEL with responsibility for the delivery schedule, the NPC's viewed this provision much as they had SETEL's technical responsibilities. When SETEL's staff first suggested that it begin production planning in December, 1960, as stated in HK42, and required in the contracts, difficulties were immediately encountered with the NPC's. Several of them rejected the idea of centralized production control and even of the charting techniques required for such control. The NPC's had reserved the planning function for themselves, for it involved the commitment of space, personnel, and other resources in their plants.

Additionally, Reijnierse had won a penalty clause which would have resulted in reduced fees for any late delivery not justified by causes external to industry. "Even though the penalties were very reasonable,[70] the extreme difficulty of contract negotiations on this point demonstrates the limited degree to which the solidarity between the several NPC's was ready to be transformed into fact; because of delivery of complete batteries, each producer feared having to assume penalties for delays for which someone other than himself was responsible."[71]

Therefore, the NPC's persisted in resisting any meaningful planning until, they could with certainty and convenience schedule the production. When the documentation/design stability surfaced at about that time, which was bound to cause an indeterminate delay, SETEL had to retreat, and made no further planning effort during 1961.

All during this time NHMO hammered at SETEL to initiate a planning system, but given the inability of SETEL to prevail over the five NPC's (also its bosses on the SETEL Conseil), the NPC's, through SETEL, were successful in resisting because of the uncertainty of all the production factors.

Though tardily, towards the end of 1961, the Conseil finally gave way to pressure from the PG's and SETEL inaugurated a system for obtaining progress reports from the NPC's on a monthly basis, as well as giving them delivery schedules with periodic deadlines. Though this monitoring process took about three weeks, progress on critical items was reported weekly so that at the monthly joint SETEL and NHMO meetings the most important information was more current. To verify the SETEL supplied progress reports, personnel in NHMO's

Production Planning Division also received progress reports from the national government surveillance services, whose personnel visited the contractor's plants to check on the quality, costs and delivery of Hawk material. But naturally, NHMO and the national governments could not follow progress as thoroughly as the contractors, and as such had to rely on SETEL for the fulfilling of the monitoring function. To expedite production, NHMO personnel did occasionally visit contractors, but always after informing SETEL, which usually sent a representative along to accompany NHMO personnel.

Despite these efforts, this continued to be a weak point of the program. Due to too little input from the NPC's and the monthly reports being too old to use as production controls or trouble indicators, this system still did not permit rapid enough reaction when the situation required it. But at least the NPC's did finally realize that only through a centralized scheduling and control operation was there any hope of obtaining the parts and raw materials in any orderly fashion.

Production continued to slip, with the five production contracts finally being signed between SETEL and the five PG's on October 16, 1963. The progress made in 1963 and 1964 was made in the face of constant NHMO-SETEL bickering, and the frustrations over obtaining parts in the U.S.

One additional point relevant to the production side of the NATO Hawk program is that it was seized upon by the five PG's as a vehicle for forcing the introduction into the EEC countries of American conceptions and methods in the area of quality assurance.

In any case, the equipment produced was of high quality—firing tests in Europe showing the systems to be at least as good as U.S. built systems. When the last missile deliveries took place in 1966 (the last batteries having been delivered in August, 1965), the total slippage was about 20 months, at least in comparison with the schedule of January, 1960 (Plan No. 7).

f. Program Cost and Comparisons with the US Production Program

The original crude cost estimates for the program (based on U.S. data) amounted to $350 million.[72]

At the time of the signing of the production contract in October 1963, the total cost was drastically revised and estimated to be $620 million to which the U.S. would contribute $30 million for grant assistance (e.g. technical assistance, technical documents, training, test equipment, etc.) and $80 million for reimbursement assistance.[73]

The final cost of the program ended up being $667 million. These figures can be misleading though. Of greater import are comparisons of costs between the U.S. and Europe for each complete system delivered. According to Robert Rhodes James the European costs were 20% greater, and according to Milton S. Hochmuth the margin was 13%. Whichever be the closest figure, all things considered, these results were quite favorable. Considerations that would further qualify the figures resulting from the comparison include:

- ancillary U.S. development costs not included in the U.S. costs;

- the costs of educating and learning, remembering that the goal of the program was not just to transfer and distribute the technology and know how to Europe for an integrated production effort, but to distribute it as widely as possible within each of the five nations. This latter aspect being further reinforced by the not inconsiderable inducement provided by the contract's being of the cost-plus-a-percentage-of-cost variety;

- on the closely related point of the costs of duplicate facilities, the tendency was more towards the maximizing of program benefits for the individual national industries, not the EEC nations as a whole;

- the costs of time lost due to problems with—documentation/design stability, U.S. procurement, the large number of European and American firms involved, and the distances to be covered between widely scattered facilities;

- the smaller scale of production.

Considering the above it is amazing that the difference is so small.

All these obstacles aside, the NATO Hawk program fulfilled an urgent military requirement for NATO, at a reasonable cost, while producing major economic and technological fallout for the participating countries.

8. NATO Contracting—The Case of Hawk

a. A Legal Impasse and a Procedural Compromise

The issue of supranational authority, inherent in such multinational efforts proved to be a stumbling block for the NATO Hawk program.[74] Though being able to draw on the precedent of the CEOA, the NATO Hawk Production Organization was the first such authority to assume the role of a NATO weapon system project office. This resulted in considerable delay in the signing of the intergovernmental agreement, the Technical Arrangements.[75]

The fundamental issue involved here was over the acquisition agency that would negotiate and sign the contract with the EPC. Was the NHMO to sign one contract with SETEL on behalf of the five PG's, or were there to be five separate, but closely related, contracts between the EPC and each government. Because of its precedential nature, this one point was hotly debated for over a year and a half, between mid-1958 and early 1960, as issue percolated up and trickled down the several national and international bureaucracies.[76]

Two reasons were stated for rejecting the alternative of a single contract. One was that the necessary administrative procedures would take too long to establish. Another was that the NHMO staff would have to be enlarged to a size far greater than had been contemplated. Yet, the real reason was whether a international body could usurp the sovereignty of a government by independently committing that government's funds.[77]

The U.S. and all the participants of the NATO Hawk program except France, saw in the Ottawa Agreement of 1951, the right to set up an organizational body, subsidiary to the North Atlantic Council and sharing its juridicial saw in the Ottawa Agreement of 1951, the right to set up an organizational body, subsidiary to the North Atlantic Council and sharing its juridicial personality. This involved an organizational body capable of concluding contracts, acquiring and disposing of movable and immovable property, and instituting legal proceedings. The PG's, with the exception of France, considered the Ottawa Agreement as being indicative of prior agreement by their governments, permit-

ting the creation of the necessary body with sufficient supranational authority for a given task. France saw the original intent of the Ottawa Agreement as being more limited. The French further argued that their national law specifically precluded any non-French agency from committing national funds—an agreement that was soon to become invalid with the changing of legislation on this point in line with the requirements of the newly forming EEC.

Nevertheless, some way had to be found around this obstacle, so that the program could move forward on firmer footing. Having seized the initiative by late 1959, and with the BOD being more than content with his performance, Reijnierse now moved to get the program out of this impasse. He carefully developed the agenda and steered discussions at the BOD meetings to favor giving the NHMO contract authority. In this he received strong support from the U.S. and the other PG's but France still would not yield,[78] no matter how logical the arguments. As a result of this position, however, France was pressured into giving NHMO more 'de facto' authority while 'de jure' authority remained with the BOD, and therefore the governments.[79] The compromise eventually reached was one involving the signing, by each nation, of a separate contract with the European Prime Contractor (EPC), SETEL, while all negotiations for preparing them would be through the single executive agency, NHMO. Even though SETEL would be contractually responsible to five national procurement heirarchies, all directives and instructions, including authorization to expend funds were by NHMO. A semblance of sovereignty was preserved by requiring a 14-day delay in implementation of instructions, so as to allow any government time to question or veto it.

The way in which Reijnierse engineered this was cited by Hochmuth as an example of how the NHMO General Manager worked with the BOD.

> The BOD still debated and set broad policy, but Reijnierse had learned how to handle each member and could keep them satisfied. Reijnierse would take action where he had to, but he was always careful to have the BOD debate and decide matters of importance. For example, when NHMO was unsuccessful in getting authority to sign the contracts with SETEL, Reijnierse did get authority to give implementing instructions to SETEL in the name of the five governments. The technique he sold was to send copies of his instructions to each member of the board; if there was no veto in 14 days, his instructions to SETEL were binding. There does not seen to have been a veto in the history of the program.80

b. The Hierarchy of Contractual Relationships

There were two principal contracts between the PG's and SETEL, one covering those operations prior to production, and the second for actual production.[81] The first of these, the preliminary contract, covered the establishment of the means of production, the study of U.S. models, and the assembly of several batteries from parts imported from the U.S. in blocks of subassemblies.[82] The production contract covered the complete batteries, spare parts and mobile workshops for maintenance.

The five PG-SETEL contracts, passed on to each of its subcontractors (i.e., the five NPC's, Thomson-Houston for the services of the Mandate, and the two engine manufacturers) were divided into partial contracts, and were in reality contracts of adhesion for the five NPC's. Due to its weak financial standing, SETEL was required to have the NPC's assume the guarantees in these sub-contracts that it could not assume itself.

In addition, all these subcontracts, be they from SETEL to the NPC's or the NPC's to their suppliers, had to be submitted for approval to the five PG's once they exceeded a certain sum.

Each of the NPC's were individually responsible for production and its quality. This responsibility extended not only to their own production but to all firms located within the corresponding national territory, i.e., even if the destination of the elements produced by these firms was to be integration into the production of an element for which another NPC was responsible.

This "geographic responsibility" was integral to the initial agreement and, not unexpectedly, proved to be problematic. Hochmuth attributed the fact that it was never resolved to structural inertia. However, as we saw in a previous section treating the NHMO-SETEL relationship, SETEL's General Manager Angles d'Auriac pointed out there were several benefits that accrued to this otherwise awkward way of coordinating the joint industrial effort.

The one exception of this "geographic responsibility" of the NPC's for subcontractors was involved with the production of the rocket motor. It had originally been planned in 1958 that the three sources of production—French, German, and Italian—would follow the program norm, acting as subcontractors of the NPC's. But the five PG's later decided in November 1959 to reduce the sources to two—one French and one Italian-German, the latter located in Italy--and that these two enterprises would be direct subcontractors of SETEL, without the NPC's as intermediaries.



c. Negotiating the Contracts

In mid-1959, NHMO, being desirous of keeping up the momentum by giving SETEL contract coverage, took the initiative in approaching SETEL to start negotiations. Reijnierse, lacking legal authority but as de facto representative of the governments, assumed the authority to bargain and negotiate. He found, however, that Angles d'Auriac did not respond in a like manner. Whereas Reijnierse would make or accept a proposal and risk the BOD's approval, Angles d'Auriac had to take every proposal back to the Conseil. Reijnierse soon became frustrated and angered at his opposite. This situation was never to improve and relations between NHMO and SETEL were henceforth severely strained. Failing to make adequate headway in these negotiations, a preliminary contract—really a letter of intent—was signed on October 30, 1959 providing for cost reimbursement, thus allowing work to continue. Moreover, this preliminary contract was not ratified until eleven months later on September 21, 1960.

So as to simplify the drawing up of the series of contracts that would be needed for the program, government experts worked closely with SETEL on the first contract to ensure agreement on a text. An important text, the General Administrative Clauses and Conditions (G.A.C.C.), was included in the preliminary contract, after long discussions with SETEL, and served as a prototype contract for all future Hawk program contracts.

This contract covered all possible administrative aspects in considerable detail and indicated margins within which the states would accept the drawing

up of future contracts. Understandably, many of the terms were similar to those used in the contract between Raytheon and the U.S. Army Material Command, but with one important difference—terms requiring SETEL to retain title to Hawk Equipment until after final system checkout at HASCO.

Though this document served well in contract guidance, it did not succeed in avoiding interminable discussion over later contracts, only reducing them. It took another 11 months before the preliminary contracts could be signed; then another year and a half for the production contract.

The approval of the subcontracts between the NPC's and their subcontractors resulted in yet a longer delay. Very few fixed prices were obtained. The G.A.C.C. (C.C.A.G. in French) did include however, a certain number of contractual limitations to avoid cascading of margins in successive subcontracts. The head of the NHMO's Technical Division, George Wenisch, stated that "... in almost all cases, all that which was allowed was practiced and the maximum margins tolerated were applied."[83]

The two principal contracts were of the cost-plus-percentage-fee type, though for a small number of elements, fixed prices were able to be negotiated toward the end of production. Because of the urgency with which the program was started, it would have been difficult to adopt any other type of contract for a task so poorly defined and so wide in scope. Moreover, the contractual norms of the five countries involved lent themselves poorly to new types of contracts. Each national government supervised execution of the contract for its industry.

Much as with the NATO Infrastructure Program, each PG paid the EPC directly, on behalf of the US and all the PG's, settling accounts among themselves on a bilateral basis. The NHMO ensured coordination and provided a general secretariat for joint action. But the fact remains that such cost reimbursement type contracts, in an international context, tend to be a considerable source of dispute and misunderstanding.

d. Financing

The costs incurred by industry are paid by the PG's and the U.S. in proportion to the number of batteries ordered by each. For example, a request for payment coming from Italy is transmitted by SETEL to the NHMO, while simultaneously a more detailed breakdown of costs, the approval of the Italian government's price control service having been obtained, is also sent to the NHMO. SETEL then divides up the sum according to each PG's share, converting each amount into national currencies according to the parities of the IMF. The NHMO then assures exact application of the rules used in calculating expenses, after which it transmits the requests, with any possible corrections, to the PG's for payment. Each PG pays SETEL through one of the five national banks in which SETEL has an account. Ordinarily each PG pays in his national currency to SETEL's bank in his country. SETEL then settles the bill with its Italian NPC in lira through the Banca Nazionale de Lavoro. But if SETEL's account in the Italian bank momentarily lacks sufficient funds, SETEL can ask certain PG's, who have previously agreed to do so, to pay in lira to the Italian bank in order to save in conversion expenses.[84]

Payments were carried out by installment in this manner up to the liquidation of the project. An initial depositing of advances served as a buffer for dealing with any irregularities in the rhythm of payments and would eventually be reabsorbed as the rhythm of expenses decreased. Once set up, this system permitted economizing financing costs, inevitable in a project of such size.

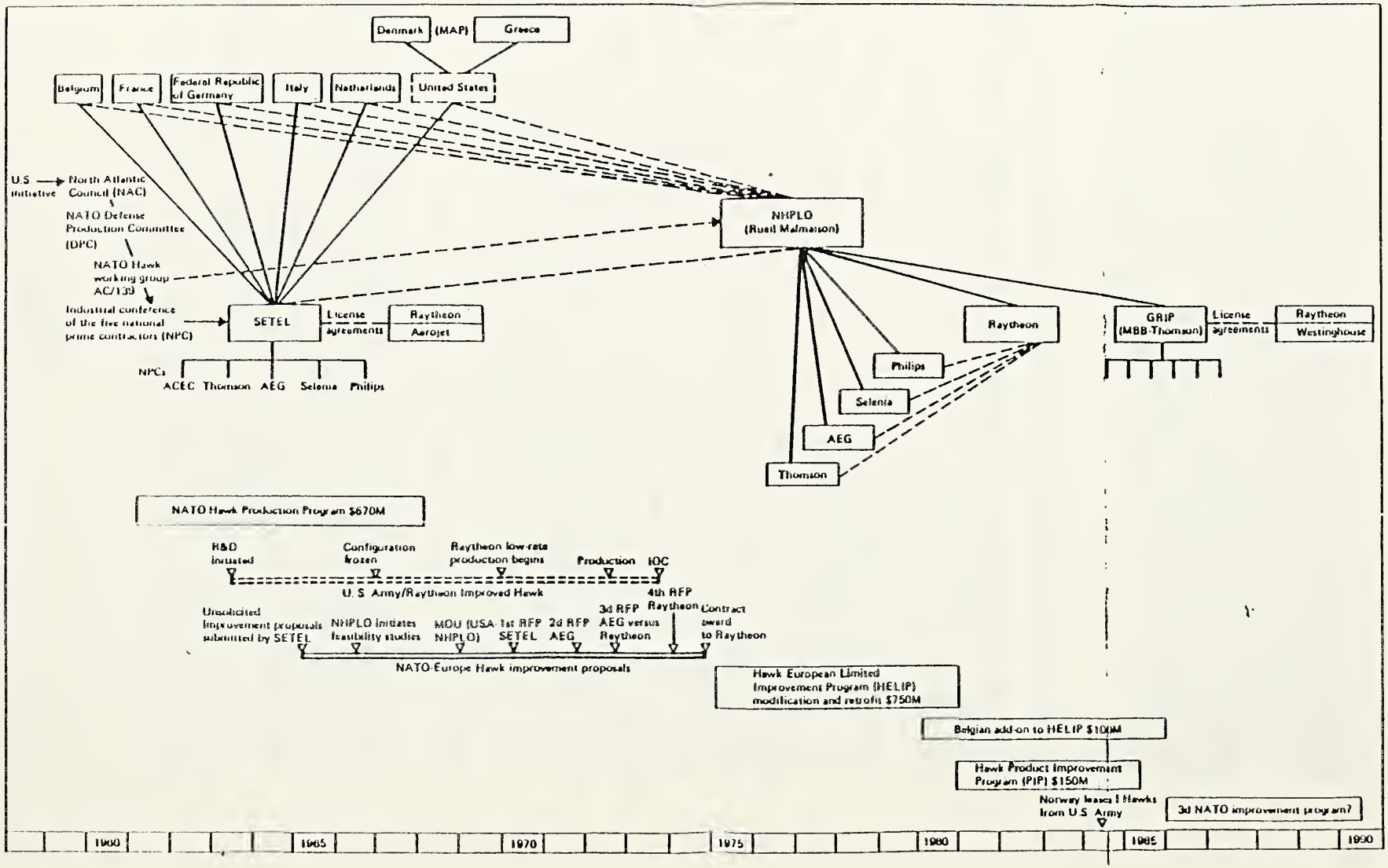
In case a given currency's exchange rate changed, the sum to be paid was adjusted the date the rate changed, in such a manner that the contractor realized no loss or gain.

e. Contract Administration

In the very sensitive area of surveillance of contractors any given government has enough difficulty with accurately determining the allowability of costs, the negotiation of overhead rates, and so forth. But when the price paid for the given system becomes a function of four other national contract administration services and their surveillance of contractor management, the result is chaos. The administration of a cost reimbursement plus a percentage of cost contract leaves the door open even wider for intergovernmental disputes.[85]

The methods and efficiency of each national service in its control of prices varies enormously from one country to another. In this non-market environment, certain 'modus vivendi' between the contractor and the government service providing control become established within any given country. In this 'sui generis' national mix, certain principles may be ignored while

NATO Hawk Production and Improvement Programs



others may be established and applied with severity, one compensating the other. Thus a unified approach to such control becomes very hard to establish.[86]

As pointed out by Wenisch,

> ... if on a certain point it is proposed that common alignment will be on the procedure that is the most favorable to industry, the most severe state will fear seeing his whole national structure of control crumbling and therefore will insist on choosing a more severe procedure. But then on the other hand, if one proposes an alignment on the most severe procedure vis-a-vis industry, its then the firm that was previously the least constrained that will resist with all its strength so as to avoid the eventuality of its own government drawing upon its adoption of this clause for Hawk for application in all its other dealings.87

In addition, the industries maintained for reasons of industrial secrecy the demand that the structure and articulation of their prices not be divulged to anyone other than their national controllers where it is held as a secret of the profession.[88]

These tensions manifested themselves as well in the Group of Inspectors which were studying these questions for the BOD. Here the defense of the interests of the customer and the search for the most advantageous procedures was opposed to the justification of national norms.

> Speaking at a symposium at the University of Liege in 1965, Wenisch stated. As the corresponding discussions took place between the clients and contractors designated in advance, having already begun work, and without the economic possibility of cancellation of a contract, and one not yet signed at the time besides, one can see that certain questions are yet to be resolved (e.g., the unification of the rates of depreciation of installations). The difficulties would certainly have been less if the NHMO had had juridicial personality, had itself negotiated and awarded the contract to a firm of its own choosing, and had itself assured control.89

However, by the time the logistics program had materialized in 1963, attitudes had evolved sufficiently for the adoption of a more rational procedure with one contract being awarded by NHMO on behalf of all the PG's. The PG's delegated contract authority to the NHMO and its agent (originally a French supply depot; later NAMSA) for the many logistics contracts. This was also a function of the less sensitive nature of logistics support, involving a greater number of smaller contracts.

9. Logistics and Infrastructure

a. The NHPO Expands Its Scope to Include Logistics

From its inception in mid-1959, the NHPO was chartered to manage only the production phase of the program. In late 1962 the participating governments (PG's) finally began to determine what policies, organizations, and facilities would be needed for the continuing logistics support phase. In May, 1963, the NAC approved a resolution adpoted by the BOD to extend the organizational functions and responsibilities of the NHPO to include logistics support for all European Hawk equipment, one month before the first European-produced Hawk battery was delivered. At this point it therefore became the NATO Hawk Production and Logistics Organization (NHPLO). With one month to go before first delivery, fortunately, SETEL had been directed to produce spare parts which would be sufficient for the first two years of battery operations, based on US logistical information.[90] In addition, US maintenance and supply manuals also were available in Europe for delivery with Hawk batteries.[91]

By October 1964, the NHMO had devoted considerable attention to plans, policies, and organizational procedures for logistic support. A target date was set for operational readiness of all Battalions and hard work was still needed to assure that all support material would be delivered.[92] "The deficiency in advanceplanning had been largely overcome, but the experience was evidence again of the necessity for timely attention to all phases of a joint production program."[93]

b. A Central Supply Depot Allows the NHMO to Circumvent SETEL

After protracted negotiations, the BOD had finally agreed to accept a French offer to furnish and operate a central supply depot under contract. Along with the depot, France, as host country, provided for execution and administration of logistics support contracts and financing through its existing organization. Other assistance in the international/national agency mix of the common logistics effort provided by national agencies were: the existing national supervisory services, for the technical acceptance of NHPLO contracts; and Italy and the FRG provided for the operation of two NHPLO Maintenance Float Distribution Points.[94]

In December, 1964 an "Agreement for Common Funding of Logistics Support" was approved by the BOD. This provided a legal basis for financing the common logistics support operations of the NHPLO—the NHPLO now being able to sign its own contracts for logistics contracts. This agreement also included the addition of what became a separate BOD for logistics, by bringing in the U.S. as a voting member for logistics matters, due to the MAP procurement. Later the two MAP recipients Greece and Denmark also came in.

The supply depot provided the NHMO with an operating agency other than SETEL—an opportunity that was seized eagerly.

> Employing its direct contracts with the Mandate, NHMO proceeded to make detailed decisions and changes concerning repair parts, including those that belonged to the prime production order and therefore were SETEL's responsibility. This led to such a clash of authority that for the first time one can find such terms as "violent", "uncontrolled follies", and similar descriptions in some SETEL correspondence. The first test of wills was a draw.[95]

In March 1965 NHMO ordered $5 million worth of parts from SETEL, so as to take advantage of the 1963 production contract prices. A second order for $6 million was to follow, but in June the NHMO abruptly reversed itself, and the order was not given to SETEL. In October NHMO, requested bids directly from 53 subcontractors, as well as SETEL.

The subcontractors were to respond both to SETEL and directly to NHMO, but some responded more slowly to SETEL. NHMO ultimately passed direct contracts through the French depot to the subcontractors for most of the parts. The five NPC's were indifferent as to whether they got the business through SETEL or directly. The NHMO was obliged, however, to award SETEL a management contract to supervise production and quality control since some common entity was needed to insure that the parts met acceptance criteria and were warranted to function properly.[96]

c. Shift of Logistics Support Functions to NAMSA Between 1965 and 1975

As covered in Chapter 4 on the NATO Maintenance and Supply Organization (NAMSO), the NHPLO gradually shifted its logistics management responsibilities

The Deployment of NATO's Integrated Central European Hawk Belt



to NAMSA between 1965 and 1975. NAMSA assumed responsibility for the Hawk from the NHPLO in several phases: calibration support in 1965; stocking of spare parts in 1968; and full responsibility for logistics support in 1975.

In 1975 NAMSA also established the NAMSO Hawk Logistics Management Operational Center to oversee a split activity; the Hawk maintenance function still taking place in Paris, while the Hawk supply activity is located at the main NAMSA facility in Luxembourg. Hawk is also one of the seven systems supported by NAMSA that involves a Weapon System Partnership where policy making authority is delegated to a WSP Committee by the NAMSO Board.

d. The NATO Infrastructure Program Funded Hawk Sites

The Hawk is one of several missile systems for which the NATO nations have collectively funded the construction of the fixed installations for an integrated central European network (including US systems) through the NATO Infrastructure Program. Problems encountered with these sites are treated in Chapter 2. The NADGE program which was to tie this integrated Central European network into the total NATO Air Defense effort is treated in Chapter 3.

10. SETEL'S Demise

The conseil signed an agreement in May 1962 which provided that all future antiaircraft missile business of the five NPC's would be channeled through SETEL. At the 1963 annual meeting of the presidents of the five NPC's, the go-ahead was given for the creation of a marketing division in SETEL, not

chargeable to the government contracts, to exploit the potential market for Hawk Batteries. Soon SETEL had offices in Oslo and Stockholm where it marketed as any arms contractor would.[97]

Yet, in every case where SETEL's marketing efforts produced a lead, one or the other of SETEL's Conseil vetoed follow-up, because the given firm felt it could handle the proposal more profitably without SETEL. Of discussions held with Sweden, Norway, Switzerland, Israel and Japan, only with Sweden did the negotiations lead anywhere. Naturally enough Raytheon, supported by the U.S. government was an active competitor. Negotiations reached the point where SETEL began production allocations to the NPC in early 1965 and requested the governments' approval to conclude a contract. But, for whatever the reasons SETEL did not get the Swedish order. After this further effort for SETEL to develop business outside of the original governmental consortium was dropped.[98]

Any future business potential that remained would be in four categories:

(1) systems up-grading and improvement;

(2) additional major items for spares and additional missiles;

(3) continued repair-parts supply and management;

(4) missile modifications or retrofit.

As was already shown with logistics support, due to the continuing frustration of NHMO over the slowness of dealing with the NPC's through SETEL, NHMO made it known that its preference was for bypassing the "empty shell" (SETEL) in

future procurement. SETEL countered by stating its case in a memorandum sent to the five PG's (not to NHMO). The memorandum pointed out that the program had accomplished its tasks, that the governments had a sizeable investment in SETEL's learning and experience which would be foolish to discard, that the NPC's were far more likely to be responsive with SETEL as a buffer than if pressured directly, and that there was now a 'modus operandi' which had overcome many problems.[99]

In 1964 the United States implemented a major modifiction to the missile which was approved by NHMO and BOD after receiving the Mandate's evaluation and recommendation on it. The work was to be done by the German and Italian NPC's at a fixed price, but dissension broke out between NPC's, SETEL and the NHMO. In the end the whole issue was solved unilaterally when the FRG simply began shipping its missiles to Telefunken.

So, after having failed to find new customers, and having been bypassed by the NHMO in the procurement of spare parts and missile retrofit work, SETEL's liquidation was finally assured. Hochmuth made the following observations with regards to institutionalization within the NATO Hawk program.

> Every human organization nonetheless has within itself institutionalizing forces, and SETEL was no exception. These were accentuated by the threat form outside in the form of the NHMO. Later they crystallized when new and future business was sought.100
>
> At its inception the program was envisaged by its creators as an ad hoc affair. That institutionalization began early in NHMO was due to Reijnierse's leadership and to the military background of the key personnel, who were accustomed to moving into new organizations, transferring their loyalties and becoming rapidly identified with a

Improved Hawk: ready to defend NATO airspace.

Improved Hawk stands ready in Europe: ready to defend NATO airspace against today's faster and more maneuverable threats. It is also a prime example of international cooperation and weapons standardization.

With Raytheon as systems contractor, production of Improved Hawk is nearing completion for seven European NATO nations—an effort that involved firms in four countries. And, under a recent agreement, a NATO consortium will soon undertake the manufacture and installation of the latest Product Improvement Programs (PIP's) for the system.

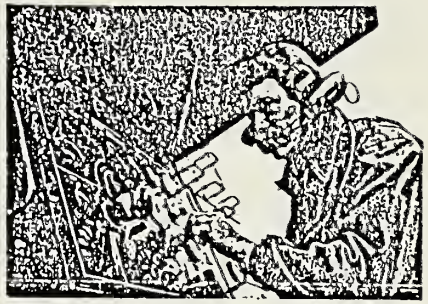
These improvements, which use the latest technology to expand the system's capabilities, were developed and produced by Raytheon for the U.S. Army and Marine Corps.

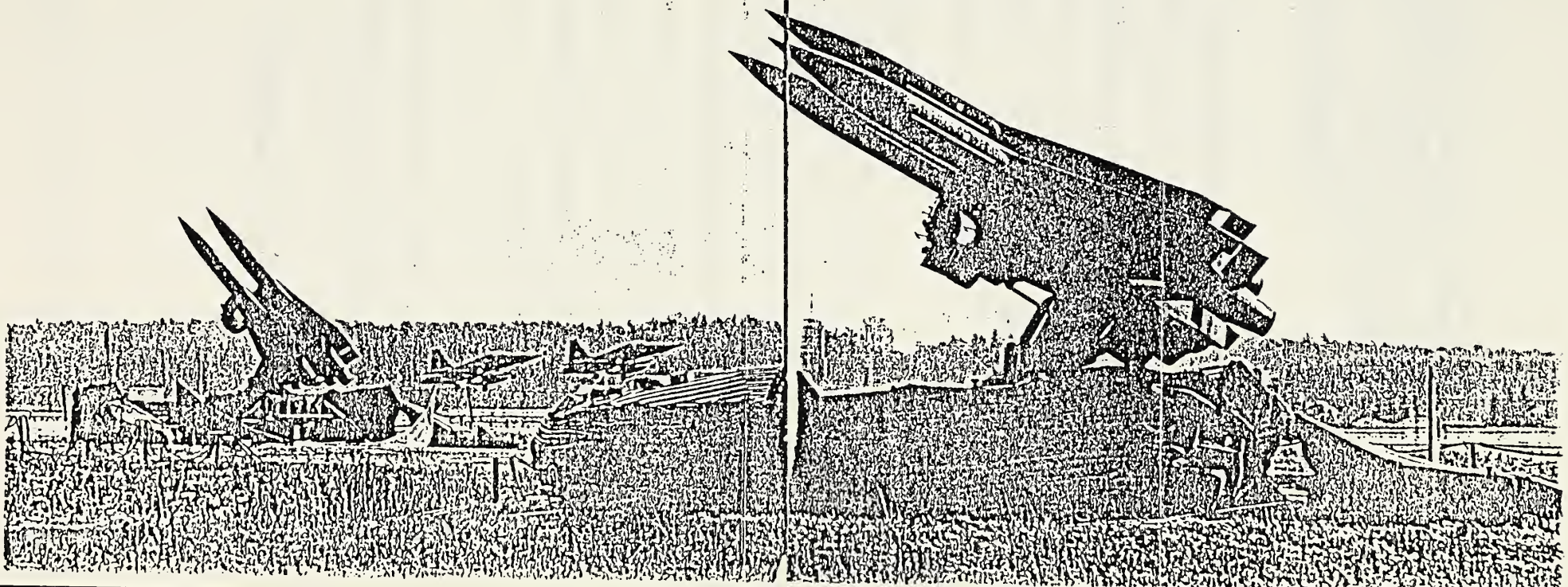
The result of this international teamwork is a NATO standardized air defense system that is capable of meeting increasingly sophisticated threats. It is a system that features advanced solid-state electronics, digital technology, and fast reaction time.

Improved Hawk can defend against aircraft flying at all tactical altitudes, from the maximum down to treetop levels. The missile itself is a maintenance-free unit that requires no field or on-site testing by the user.

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RAYTHEON





new organization. The opposite situation at SETEL has been amply covered. ...we would not expect the HAWK agencies to perptuate themselves. But of course organizations tend to become ends unto themselves. It is interesting to trace the waxing and waning of the opposite tendencies.101

11. The 1968 NHMO's Analysis of the NATO Hawk Program

The following is a synthesis from the Cornell study of a NATO study entitled: "NATO-Hawk, Analysis of the Problems Raised by the Structure of a possible HELIP Programme," HMO/4.81.02/5248,68, original French, 1 November 1968. The study was carried out so as to draw conclusions from the NATO Hawk experience that would be valid for the followup Hawk European Limited Improvement Program (HELIP).[102] The Analysis recommended as follows:

(1) the choice of industrial/governmental coordination over purely governmental;

(2) as for form, the choice of an interindustrial type of coordinating firm (like SETEL);

(3) an early discussion and agreement on allocations of orders with no subsequent changes;

(4) such allocation of orders to be made on the same scale as the nonrecurring costs and based on the number of batches contemplated by each State;

(5) that licenses and technical assistance rights belong to the governments;

(6) the use of comprehensive, cost reimbursement type contract, based on price rates, with the negotiation of a fixed price as early as possible, and the use of incentives and penalties-the type best suited to the plan of industrial coordination by an interindustry firm;

(7) and finally, that whatever contract solution is arrived at, separately between each country and contractor, or grouped together under single management-those relating to tooling, production, and additional orders should be established and managed by a single organization, to insure equality and standard prices.

12. Lessons Learned

As with virtually all of the project histories in this paper, the NATO Hawk program offers one much more than simple, 'lessons learned'. This project in particular though, stands out due to: (1) its historical significance within the overall development of transnational enterprise over the last three decades; and (2) as a consequence of (1) above the resultant depth of the research that the project has been accorded. Unlike the other two NATO weapon system projects launched in the same year, 1959 - the Atlantic Maritime Patrol aircraft and the Sidewinder AIM-98 projects - the NATO Hawk project moved outside the national military procurement systems (French in the case of the Atlantic, and German in the case of the Sidewinder). Thus with Hawk we saw the establishment of the first NATO weapon system project office, and with it all the organizational, legal, and procedural precedents which logically

NATO HAWK PROJECTS

	Years	Value	Prime Contracors for NATO - Europe Programs	Procuring Authority	Participating Nations
NATO Hawk (Basic)	1958-67	$670M	Paris based Societe Europeenne de Teleguidage, SETEL, co-owned by five national prime contractors: ACEC (Belgium); AEG (FRG); Philips (Netherlands); Selenia (Italy); and Thomson (France)	Five National Governments and the NHPLO[1]	Belgium, France FRG, Italy, Netherlands, (& U.S.[2])
Hawk European Limited Improvement Program (HELIP)	1967-80	$750M	Raytheon's Paris based subsidiary RAYTAS, subcontracting 40% of work package to Italian, Dutch, French and German firms	NHPLO[3]	Denmark, France FRG, Greece, Italy, and Netherlands[4]
Hawk European Product Improvement Program (PIP)	1980-84	$150M	GRIP (a Groupement d'Interet Economique, co-owned by MBB and Thomson) subcontracting to firms of all seven participating nations	NHPLO	Belgium, Denmark, France, FRG, Greece, Italy and Netherlands

[1]The NATO Hawk Production and Logistics Organization (NHPLO) is located at Rueil Malmaison near Paris. It was the NATO Production and Logistics Organization (NPLO) managing the NATO Hawk Project for all five European governments procuring the Hawk system. However, for Basic Hawk, each government contracted on its own directly with the industrial consortium, SETEL. For HELIP and PIP, the NHPLO both contracted for, and managed the programs for all participating governments.

The NATO Maintenance and Supply Organization (NAMSO) located in Luxembourg, entered the picture gradually between 1965 and 1975 as the NPLO responsible for the support of deployed Hawk systems (e.g. calibration, maintenance, and spares support).

[2]The U.S. also participated in NHPLO as the government owning the Technical Data Package being transfered to the NATO - Europe consortium, i.e., as a non-voting member except in the areas of security and configuration control, where the U.S. maintained the right of veto. The U.S. was also a procuring government (through MAP) for those Hawk systems built by SETEL for deployment by two additional NATO member states, Denmark and Greece.

[3]Greece and Denmark later joined the NHPLO and participated directly on their own behalf in the procurement of the Improved Hawk (HELIP) and European Product Improvement Program (PIP).

[4]Belgium did not join HELIP until 1979 as the project was winding down, entering under special arrangements that include several bi-lateral offset arrangements, which amounted to a guarantee of 100% flow-back of expenditures totaling approximately $100M. (See Chapter II.)

followed. In any case, I will proceed with this exercise and isolate a few of the more salient lessons learned, be it running the risk of misrepresenting the totality of the management know-how actually offered by this project history.

(1) As with such other projects as the US Roland, SAM and the F-104G fighter, the shipment of documentation to the licensee(s) and the related problem of a yet to be stabilized configuration proved to be unexpectedly problematic, and could have been much less so if the problems had been forseen and the parties had been adequately set up for dealing with them.

(2) Though, as we saw with the Atlantic project, a certain amount of instability in the national orders is inevitable and must be dealt with, a set of incentives should be set up so to minimize this, and any resultant program disruption.

3) The procurement of parts in the US through routine US Army supply procedures (geared to repair parts procurement), though offering economies in administration and unit price, led to a serious disruption of the production schedule.

(4) The formation of the industrial consortium through a 'shot gun wedding', was not followed by the governmental consortium's creation of an adequate set of incentives that would allow this to be an effective marriage of industrial interests.

(5) The requirement for unanimity in decision making does not present an insurmountable obstacle to reconciling national sovereignty and project management once the grouping had been reduced to one of sufficiently like-minded nations, that are willing to relegate the exercise of sovereignty to the policy (BOD) level.

(6) And taking the above one step further, a comparison of the experiences of the two international project management offices - one governmental and one industrial - reminds one of the necessity of granting not just responsibility, but adequate authority as well, to the General Manager so as to allow a directed, and not an ad hoc approach to project management (one that requires concensus formatin prior to decision making and as such subjects the project to the 'immobilisme' and a reactive posture).

(7) In the unstructured arena of transnational project management the personality of such key players as the governmental and industrial General Managers can have a major impact on the evolution of the project, and inter-organizational relationships.

(8) In this case as the project evolved, we saw a reversal of the original intentions of the key players (as with the NADGE project) as to the roles that each would play, e.g. which one among the players would assume the lead role, the participating governments (PG's), the NATO project office, or the European Prime Contractor (EPC).

(9) The institutionalization process as it related to this project was a net advantage in that, of the two international organizations set up to manage it, the more fit survived to offer the know-how accumulated for working future projects - the weaker one perishing.

(10) There is a crying need for more studies of transnational enterprise that are of the rare quality of Miton S. Hochmuth's book, Organizing the Transnational.

B. F-104G

1. Introduction

No single joint weapons project within the Alliance has aroused fiercer controversy throughout its life than the F-104G Starfighter Mach 2 multi-purpose aircraft. Being the largest such project until the MRCA Tornado, needless to say, it had high visibility. The controversy over the choice of the aircraft by the 4 NATO member states can be kept separate from any discussion here on the manner in which the project was administered. Furthermore, the subsequent misfortunes of the aircraft in service have never been attributed to deficiencies in the production program.[103]

a. Selection of the F-104 by the FRG

In October 1958, after examination of the Lockheed F-104, the English Electric Lightning, the deHavilland Firestreak, and the Dassault Mirage III, the Luftwaffe High Command and BWB [104] selected the F-104 Starfighter.[105] The decision was made public in December.

Both Japan and Canada had previously selected the F-104 as well, and were producing their own versions under license (the F-104J and CE-104).
The F-104 was powered by a General Electric J-79, and its ordnance included 4 Sidewinder AIM-9B air-to-air missiles (a system also produced under license in Europe as part of a separate 8 nation production agreement), one 20mm cannon, and 4,000 lb of bombs. Maximum speed was 1,550 mph at 40,000 (with a ceiling of 58,000 ft) and a range of 1,380 miles.

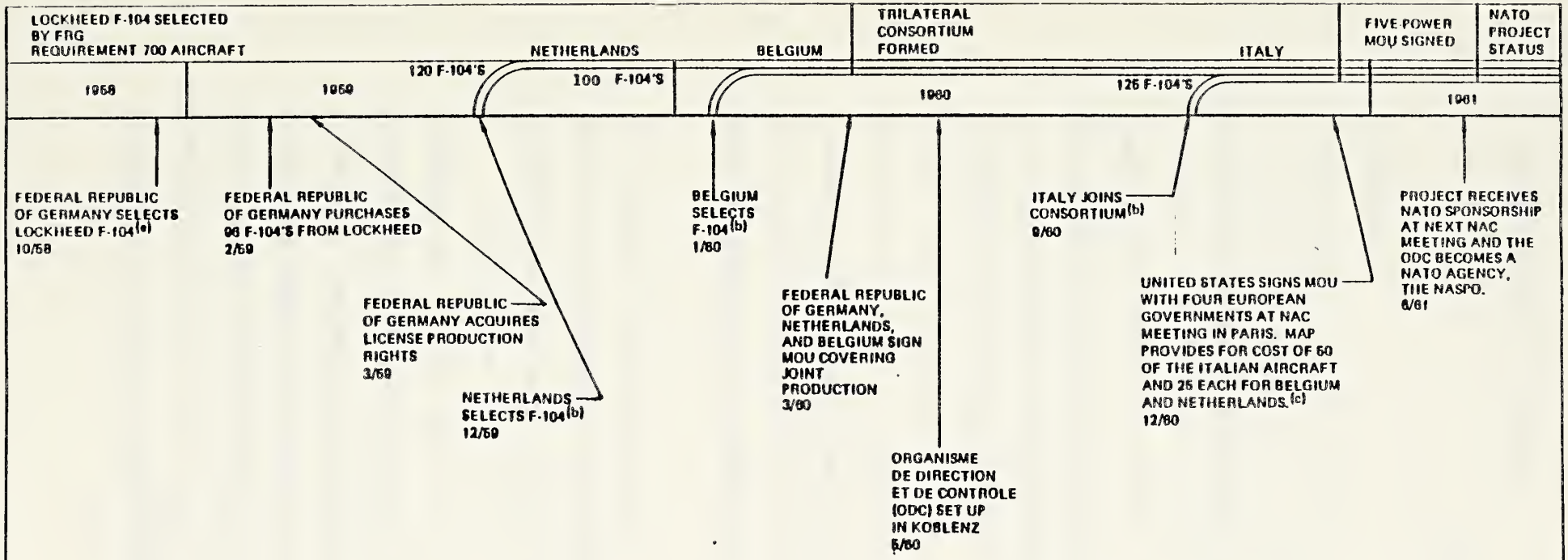
On February 6, 1959, the German government and Lockheed signed an agreement covering the delivery of 96 F-104G Starfighters to be built in the U.S. Six weeks later on March 18, the FRG and Lockheed signed an agreement which covered the acquisition of license production rights and guaranties of technical assistance for the production of 210 aircraft. These aircraft, however, were to be radically different from that originally offered by Lockheed.

For the F-104G multi-role variant of the Starfighter the structure and undercarriage were strengthened, the engine was more powerful, the wing's surface was extended, and more sophisticated electronic equipment was installed.

The F-104 Starfighter had been developed to meet a requirement, emanating from U.S. Korean War experience, for a lightweight air superiority fighter. The first flight of the XF-104 had taken place in February 1954, and the first delivery of production F-104As to the USAF was in January, 1958. The FRG however, wanted a multimission type aircraft capable of operating as an interceptor, an all-weather fighter, a fighter-bomber, and a reconnaissance aircraft. Therefore, Lockheed contracted with the FRG to develop this multipurpose version of the F-104 Starfighter, designated the F-104G Super Starfighter.

Vandevanter researched the intensive competition and bargaining that preceded the selection of the F-104G and offered the following comment concerning the roles played NATO's international staff, the national governments and their industries:

THE F-104G CONSORTIUM TAKES SHAPE OUT[illegible] OF NATO ORGANIZATION AND PROCEDURES



[a] F-104 was selected over the British Lightning and Firestreak and French Mirage II.

[b] Lockheed signed license and technical assistance agreements with the Government shortly thereafter.

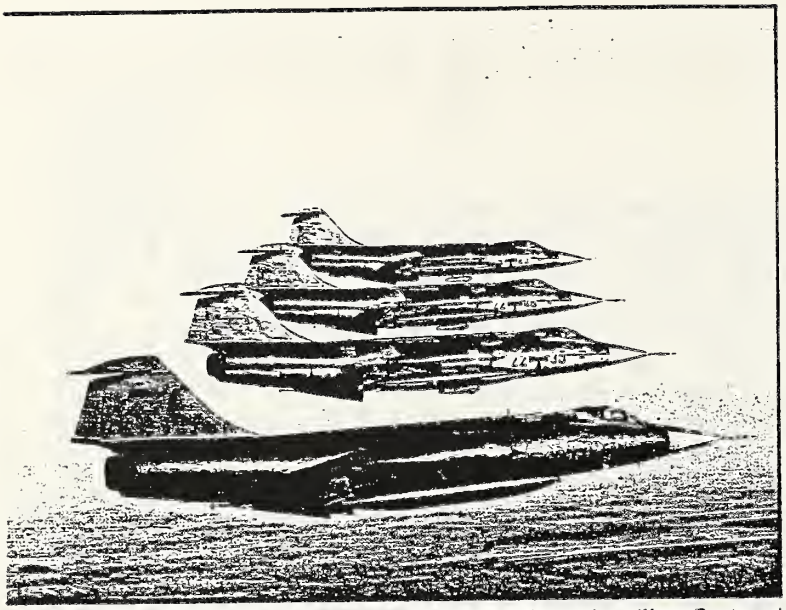
[c] MAP also provided F-104's to four other NATO members shortly thereafter (Denmark, Norway, Greece, and Turkey); 81 came off the Lockheed production line in California and 140 off the Canadair line in Montreal (where another 240 were produced for the RCAF).

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> The F-104G consortium did not come about because of any superior procedure or concentrated international effort. It resulted from old-fashioned, bold, and persistent salesmanship of a good product. Whether the successful sales campaign was carried out by the manufacturer (Lockheed) or the government (United States) or both is not particularly important to us; there can be no doubt that the international network (military and civilian staff and committees) remained aloof from the negotiations. No one questions that other manufacturers—American, French, and British— were extremely active and brought all pressures to bear on the German government. Arrangements were not promoted by the international network for the simple reason that France and Britain would have blocked any intervention that appeared to favor the American system. The American government was precluded by tradition from making a selection among competing U.S. models.106

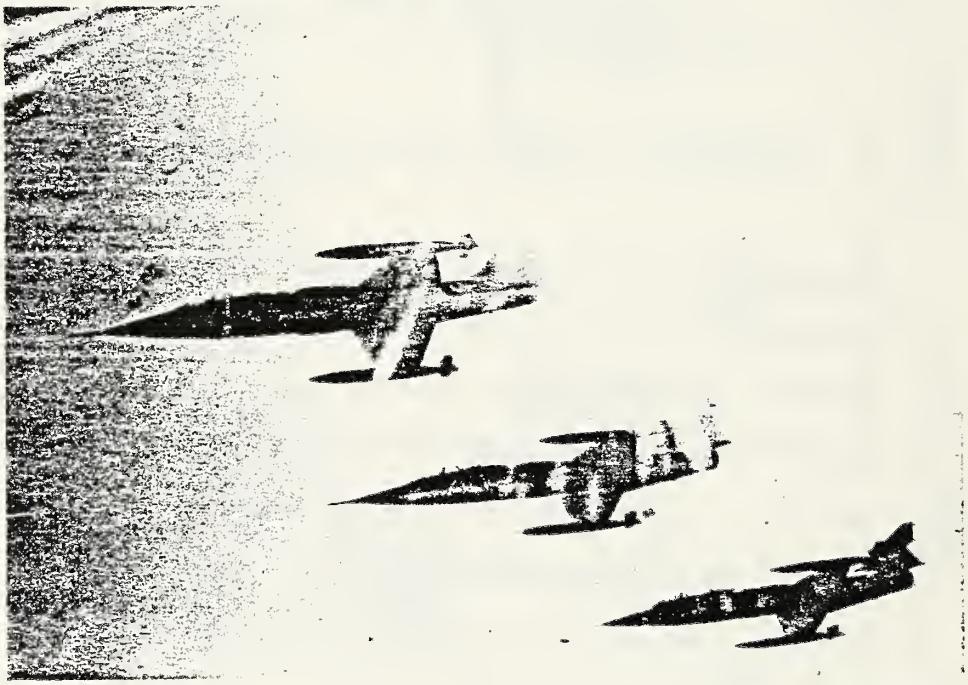
b. A Consortium is Formed, Later Receiving NATO Project Status

The issue of licensed production versus direct purchase had pitted the Adenauer's Finance Minister, Erhard (later Chancellor) against has Defense Minister, Strauss. Erhard had felt that it would be undesirable to rebuild a German aircraft industry while Strauss considered its rebuilding to be highly desirable. Strauss prevailed. Realizing though, that the German aerospace industry could not undertake any such project on its own at this stage, and in line with her policy of integrating all defense related efforts into a NATO context, the German government began to look for other Alliance members that might have a similar requirement. Practically all the NATO members were in need of replacing such older aircraft as the U.S. F-84 and F-86 and the British Hawker-Hunter, for which the U.S., the U.K., and France each had excellent candidates.



Formationsflug von vier F-104G des JaboG 34 irgendwo über Portugal

FLUG REVUE



Italian Air Force TF-104 Starfighter jets ▸

Military Technology MILTECH



When the FRG alone signed with Lockheed in March 1959, negotiations were already underway towards interesting other alliance members in forming a consortium of manufacturers. At the end of 1959, more than a year after the German decision, the Netherlands decided to adopt the Super Starfighter, being followed by Belgium in early 1960. By early March a basic agreement had been reached by all three governments covering the joint production of 739 aircraft, and the protocol and its Accord No. 1—establishing the production consortium, work sharing arrangements and regulations—was signed by the three nations. Following this a joint intergovernmental project office, the Organisme de Direction et de Controle (ODC), was set up in Koblenz in May, of 739 aircraft, and the protocol and its Accord No. 1—establishing the where the BWB provided office facilities and clerical personnel.[107]

Six months after the joint Belgium-Dutch-German program had been launched, Italy joined the consortium of governments as well, in September 1960, after having signed license and technical assistance agreements with Lockheed. This brought the number of European participants in the program up to four, being the same grouping as for NATO Hawk, except for the absence of France, who in this case had its own competing system, the Mirage.

A formal five power memorandum of agreement between the U.S. and the 4 European nations was signed at the North Atlantic Council—Ministerial Meeting held in Paris in December, 1960. Though the NATO institution was used as the body at which the official announcement of the production agreement by the five member nations would be made, the consortium had been formed outside of

the NATO structure and its procedures (contained in the recent NATO Document C-M(59)82). In June, 1961, the joint project received NATO sponsorship and the ODC became a NATO subsidiary Agency, the NATO Starfighter Production Organization (NASPO).

The following reasons were offered by Vandevanter to explain why a consortium such as the F-104G Starfighter, formed outside of the NATO structure would be interested in placing themselves under the NATO aegis.

> First, member nations find that tight fisted parliaments allocate funds more readily for weapons that bear a NATO stamp of approval. Second, commercial operators are spared many tax and customs problems with NATO equipment. Third, classified material is easier to control through established NATO channels. Fourth, personnel associated with NATO consortiums often enjoy certain quasi-diplomatic privileges in foreign countries. And, finally, some countries, the United States among them, encourage manufacturers to place their ventures under NATO sponsorship in the belief that such projects strengthen the bonds of the Alliance.[108]

c. Major Program Milestones

By the end of July 1963, after a major barrage of press criticism for cost rise and schedule slippage the project had overcome most of the difficulties encountered, and had begun series production. By July, 1964, 65% of the program's total production of almost 949 aircraft (2 crashed before delivery) had been delivered, with the balance delivered by the following year, 1965.

As of August 1969, despite the recent crash of the 99th German F-104G, the Luftwaffe announced that it had reduced the accident rate for the aircraft to

a rate of 10.8 per 100,000 flying hours during the first six months of the year. The rate had been 83.6 in 1965, 12.6 in 1967 and 14.7 in 1968. The Luftwaffe Chief, Lt. General Steinhoff said that the critical time for pilots in the F-104G was when they had between 500-800 hours of flying times. Most of the Luftwaffe pilots were as of that time approaching the 1,000-hr. flying time in the aircraft.[109]

d. Procurement of the F-104 by Five Other NATO Member States, and a later variant by Italy

As of the mid-60's, Canada had produced 238 CF-104 Starfighters for its own use (200 single seaters and 38 two-seat CF-104D's) and 140 F-104G model Starfighters for a joint U.S.-Canada Military Assistance Program at its Canadair facilities

in Montreal. This production took place within the framework of the U.S.-Canadian Production Sharing Agreement covering other programs as well. This unique umbrella agreement traced its origins back to the so-called "Hyde Park Agreement" of April, 1941.

Meanwhile, the US had provided a substantial number of the new F-104G's, for the air forces of four other NATO member states as well, financed under the Military Assistance Program. These were destined for Denmark, Norway, Greece, and Turkey.[110] Eighty-one aircraft were ordered initially to be manufactured in Canada for transfer to these countries under cost-sharing formulas.

Fiat later produced another 205 Starfighters under license, but of the F-104S variant. As with the earlier license the Italian government acquired the license. The F-104S was characterized by an overall increase in performance, the installation of a more powerful version of the J79 turbojet (also built under license), and more modern electronic apparatus. The F-104S first entered service with the Italian Air Force in 1969, representing the last variant of the F-104.

2. Governmental Organization-NASPO

a. BOD

At the head of the intergovernmental organization, the NATO Starfighter Project Office (NASPO), was the Board of Directors (as is the rule with such NATO agencies). The five top level policy makers were representatives of their respective Ministries of Defense (the four European participants and the U.S.). The Board of Directors (BOD) followed the usual principles of unanimity and one-country-one-vote, but the U.S. had a vote only in a limited number of specific questions. Two other representatives, one from the Secretary General of NATO and later one from SHAPE sat in also, but only as observers, neither of them having any voting power.[111]

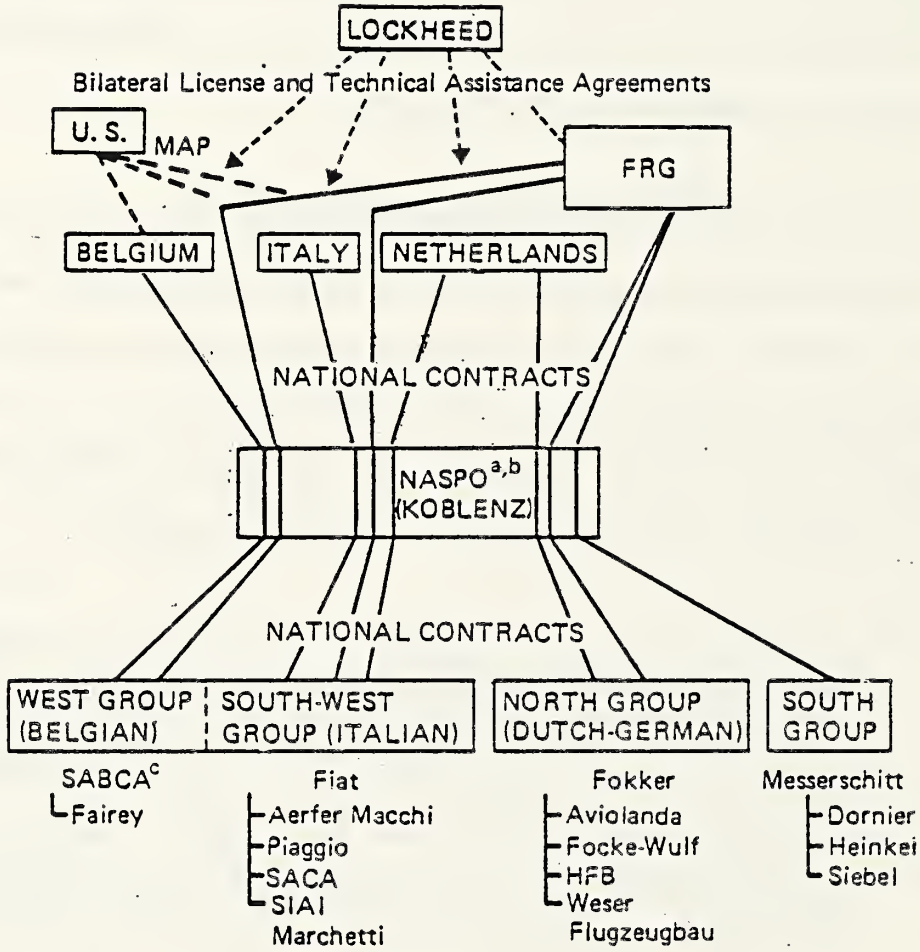
The chairmanship of the BOD rotated annually with the first chairman being General Zattoni, the Italian representative. The BOD met once a month, usually in Koblenz and the meetings lasted three or four days.[112]

Unique to the NATO F-104G Starfighter Program (among joint weapon system projects at least) was a higher level organization than the BOD, one referred to as the "Conseil des Sages". This consul was composed of four high level representatives, i.e., one delegate of each of the four ministers of defense. Unlike those of the BOD, these four did not have NATO status. The consul met only occasionally, and its mission was one of providing NASPO with broad policy guidance and to deal with the most delicate issues faced by the program that could not be resolved at the BOD level.

Unlike such other inter-allied programs as the Hawk and the Atlantic, the familiar principles of unanimity seriously impeded the decision-making process of the F-104G BOD. Vandevanter reported that many observers believed that it was only through the magnamity of the FRG that the program was carried out successfully. Even with the FRG giving way frequently, the BOD was apparently unable to make many decisions on time. To quote Vandevanter:

> In the beginning of the program, its failure to act on items with a long leadtime became so critical that it threatened to jeopardize the whole production schedule....according to reliable sources, only the courageous initiative of the top leadership on NASMO saved the program. The director (NASMO) and his deputy made commitments to contractors, which, fortunately, were later ratified by the Board. These officials were taking great risks, however, and they were subjected to considerable criticism by Board members for their initiative; it is doubtful that in a future case they would be willing to take similar action.113

Use was also made by the BOD of purely advisory bodies, called Consultation Committees, that were brought together for specific purposes such as review of the overall organization of the agency, its budget, or to deal with certain matters relating to customs.



Notes:

[a]The NATO Starfighter Production Organization Management Organization (NASMO) coordinated host-country preparation of contract clauses. The procuring governments signed contracts individually.

[b]NASPO relied heavily on support from the following: the USAF Liaison office, the RCAF Liaison office, BWB (support services), and the Lockheed advisory office—all colocated in Koblenz.

[c]The west and south-west industrial groups were actually one integrated production grouping except for final assembly.

Figure . European Production of F-104 G (under license from Lockheed)

b. NASMO

Below the BOD a permanent executive body called the NATO Starfighter Management Office (NASMO) was created under the direction of a General Manager, a German civilian by the name of Gellschopp. Below the General Manager were his two major assistants, a Deputy Manager and a Weapons System manager.

Below the Deputy Manager were the chiefs of the seven major functional departments. Their titles were: Department I, Technical Liaison; Department II, Weapon System Planning, Configuration Control and Reporting; Department III, Price and Contracts; Department IV, Airframe, Engine, General Equipment; Department V, Electronics, Ground Support Equipment; Department VI, Inspection, Acceptance; Department VII, Executive Secretary. Two departments heads were German, one was Dutch, two Italian, and two Belgain.[114]

It is with the second assistant to the General Manager, the Weapons System Manager that one sees a significant difference from the NATO Hawk Management Organization (NHMO). The F-104G program lacked any industrial coordinating counterpart to NASMO, such as SETEL for the NHMO. It was this Weapons System Manager, in a separate part of NASMO from the Deputy and his functional departments, that accomplished this for the F-104G program. The Weapons System Manager oversaw four semi-autonomous manufacturing consortia.

The Organisme de Direction et de Controle, followed by NASPO, were originally set up to coordinate the activities of the various national governmental agencies and legislatures, each jealous of their perogatives, and thereby simplify the task of the industries that had to deal with them while carrying the project to fruition. However, as was to once again occur with the related NATO Air Defense Ground Environment (NADGE) in the late 60's, this original objective was greatly subverted. In the words of Andre Regout of Fabrique Nationale speaking in 1964:

> At first, NASMO appeared to be able to deal in the name of all the governments, as the one official customer. In practice its powers were rapidly limited—too limited—by the governments. These left it with a role of coordinator, adviser, preparer and editor. The governments almost always redisccussed all contracts, re-examining each text in detail without concerning themselves with decisions taken by NASMO. However, NASMO's activities were very useful. Its spade-work paved the way for the division of work among the firms, and the preparation of preliminary contracts, the general terms and conditions document, and firm contracts.115

Captain Cornell (U.S.N.) offered a somewhat different evaluation in his 1969 study.

> If the NASMO BOD suffered from slow progress and tardy decision making, no such criticism was leveled at NASMO. As a more comprehensive agency with greater responsibility than the NATO Hawk and Atlantic Management Offices, NASMO's management powers and strong direction reached beyond the usual areas, into production planning, supervision, and practically every phase of industrial management short of actual production.[116]

Serving as both the central governmental agency and industrial agency for the F-104G production program. NASMO received praise for its amazingly small size of only 158 staff personnel and an annual budget of $500,000. It was a small

but highly efficient agency made up of dedicated specialists from the top down. NASMO naturally, relied on the various other governmental and military agencies for support where needed.[117]

Within its broad responsibilities to coordinate, supervise, and direct the entire production program NASMO received full procurement authority (a responsibility the ODC had not had) and direct responsibility for procurring technical assistance personnel from Lockheed to assist in the program. In actual practice NASMO did not perform the procurement function but delegated activities to individual authorities within the four participating European nations. U.S. industrial experts providing technical assistance were assimilated within the staff of NASMO in the early phases of the program. Though mainly from Lockheed, General Electric and avionics suppliers also provided advisors.

NATO Document, C-M(55)15 had been previously drawn up to cover all personnel and materiel security matters. Industrial security, that is, the security of drawings, technical specifications design, installation, and performance data, etc., was covered by a NASMO prepared check list, periodically reviewed. A visitor security procedure was worked out jointly by NATO and NASMO. The governments were required to inform NASMO in advance of all persons who had

to make visits in other consortium contries. It was the concensus of most observers that classified material for such joint enterprises is easier to control through established NATO channels.[118]

As is the norm for customs in such programs, the Technical Arrangements provided that, "insofar as existing laws and regulations permit, the participating Governments will assure that custom duties or similar charges or quantitative restrictions on imports or exports shall not be imposed in connection with the carrying out of this project." Although in actuality this did not lead to complete exemption of custom duties, the agreement to, and implementation of temporary importation regulations made it possible to preclude the constant transfer of funds from one Government to the others for payment of import duties.[119]

c. Major Problem Areas Faced by NASMO

Several major problems confronted NASMO in its management tasks. One of these was the lack of timely decisions coming down from the BOD. As with Reijnierse in the NATO Hawk Program, it was often due to NASMO's director having taken the initiative, and then hoping for approval by the BOD, that many key decisions and long-range plans and commitments were able to be made.[120]

The task of incorporating the desires of the three original participants had been a difficult enough task. But then when Italy entered the program, NASMO was obliged to establish a new work distribution plan and timetable.[121]

NASMO's task was further complicated because the development of the aircraft was not complete at the beginning of the program. That is, the configuration of the F-104G version of the F-104, was considerably more advanced than that of its forerunners since it was to be expanded in its mission to include fighter/bomber/reconnaissance tasks. These combined missions required a substantial increase in the electronic systems, with numerous engineering changes having to be introduced during the lifespan of the program.[122]

Along with further development and new mission requirements there was the unreliability of several items affecting flight safety and operational characteristics. To cope with these problems, working procedures to provide a uniform method for processing and incorporating the Engineering Change Proposals (ECPs) had to be prepared by NASMO. Three ECP Sub-Panels were created and given authority to decide on the acceptance of a proposed change, one each for the airframe, the engine, and the electronic system.[123] By better controlling proposed changes, the effect of modifications upon delivery schedules was held to a minimum.[124]

In the technical area, NASMO had to resort to the laying down of all possible detailed procedures in writing. The NASMO bulletins not only proved extremely helpful in keeping the various firms well informed, but were also another worthwhile addition to the techniques of international coproduction procedures.[125]

Quality Control methods and procedures were carefully governed through this series of NASMO bulletins. The fundamental rule of Quality Control in the Consortium was that national inspection sources in each country would be recognized as the authority for products manufactured in that country. This work was to be provided free of charge for all the members, by each nation. Reportedly, it worked well.[126]

NASMO also faced difficulties in the contractual field because of different national laws, regulations, and contractual methods. In order to help resolve these, NASMO and the Consortium governments drew up and published the Governments' detailed procedures for cooperation in a document titled, General Terms and Conditions for Procurement Contracts under the F-104G NATO Starfighter Production Program.

This document later proved to be of great value and has since become a valuable guide for future cooperative ventures involving complex contractual agreements.[127]

3. U.S. and Canadian Liaison and Assistance

Both the United States Air Force and the Royal Canadian Air Force also established Liaison Offices to assist NASMO. As the CF-104 was being built under license in Montreal and certain components were being made in Canada for use in the European F-104G's, a special RCAF liaison office was established in Koblenz.[128]

The U.S. Air Force created a liaison office, the USAF Koblenz F-104 Office, in January 1961, for the purpose of lending advice and assistance. The USAF Liaison Office was particularly useful to the NASMO General Manager with respect to U.S. procurement programs, engineering and configuration questions, and U.S. weapons management practices. In addition, the Office maintained liaison with the U.S. Military Assistance Program and took on responsibilities for U.S. Grant-Aid payments and U.S. inspection assistance.[129]

A U.S. Military Assistance Fund of $145 million underwrote the cost of 100 of the European produced F-104G's—50 for Italy, and 25 each for Belgium and the Netherlands. The fund was available over a three-year period to cover the purchase of components in the U.S. equivalent in value to the 50-25-25 allotments. The U.S. also provided credit for assistance of technical advisors in the amount of 30% of their services.[130]

In addition, to complement the USAF Koblenz F-104 office, a high-ranking U.S. Air Force official was assigned to NASMO for two years as a weapons systems management advisor to the General Manager. The decision to appoint a U.S. Weapon Systems Management Advisor, however, was made rather late, arriving when the program was well advanced. Therefore, his services were not available during the most critical time of the program, when the initial problems of organization, planning, development and allocation were being faced.[131]

4. The F-104G Industrial Effort

On the industrial side, organizational direction was carried out by a consortium of four autonomous, but highly cooperative industry groups under the overall coordination of NASMO. There was no single industrial coordinating body as in SETEL for the Hawk, and SECBAT for the Atlantic. Within the constraint of having their sub-contractors assigned to them by the government consortium, the four national prime contractors had the freedom to select whatever organization they felt was best.

Looked on as a waste by some observers, this complex industrial organization was deliberately set up so as to enhance the industrial capacity in each European producing region. Cost considerations were not paramount. Apart form the duplication, there is no serious evidence that the regional or group breakdown mechanism worked other than satisfactorily.[132]

Upon start-up, the industries were faced with three initial conditions:

- the need for an extremely rapid start up in production so as to allow the governments to fulfill an urgent military requirement;

- the objective of as accelerated a Europeanization of production as the above constraint would permit, and;

- the freedom to organize administratively and technically within the constraints of a pre-assigned team of subcontractors.

The license agreements were negotiated on a piecemeal basis over a two year period between the beginning of 1959 and the end of 1960 for F-104G production in each country. In the FRG and Italy the licenses were negotiated by the governments, (thereby each assuming the role of licensee), and in Belguim and the Netherlands with the industrial firms concerned.

As an example, for the three industrial firms producing the General Electric J79 engine it was not until February 1962 that an agreement was signed with G.E. which covered integration of their production efforts (one in which their was no duplication of manufacturing, only final assembly). The original three licenses had limited each of the licensees' engine production to the national territory and to quotas comparable to, and for delivery to its national aircraft order. Following the signing of the first license with G.E. in February, 1959, it was another three years before the agreement was signed allowing for a rationalization of production and the exchange of components and sub-assemblies between the three firms. The February, 1962 agreement called for payment to G.E. of fees only upon delivery to the customer government, eliminating the need to pay fees for the exchange of components between firms. In it G.E. also agreed that the ultimate destination of the components determined which license was applicable, while authorizing each manufacturer to sell its engines to any of the four governments. In the words of Andre Regout, Chairman of Fabrique Nationale, "Three years were required before this issue could be settled; this was obviously much too long, especially if one considers that for the engines (as for the airframe) there was only one licensor, the General Electric Company."[133]

The value of the system's major elements broke down as follows: airframe, 41%; engine, 20%; electronic systems, 27%; and AGE, 12%. Certain components were bought directly by the four governments and supplied to the contractors as GFE. Others were purchased directly by the four end-assembly firms acting as prime contractors for their individual groups. For example, the governments did not buy a completed aircraft, but delivered to the airframe prime contractor as GFE the engine as well as a large percentage of the electronic systems.

The four European Airframe Groups and the member countries and industries were as follows:

South Group - (FRG)	Messerschmitt (for final assembly and flight testing); also Dornier; Heinkel; and Siebel;
North Group - (The Netherlands)	Fokker (for final assembly and flight testing); also Aviolanda; Focke-Wulf; Hamburger Flugezeugbau; and Weser Flugezeugbau;
West Group - (Belgium)	SABCA (for final assembly and flight testing); and Avions Fairey;

South-West Group - (Italy) — Fiat (for final assembly and flight testing); also Aerfer Macchi; Piaggio; SACA, and SIAI Marchetti.

Source: Cornell

The South-West (Italian) and West (Belgian) groups, unlike the other two, were really integrated, with two assembly lines.

The division or orders and production of the 1,045 F-104G's ordered by the four European nations was as follows:

	Belgium Air Force	Italian Air Force	Netherlands Air Force	German Air Force
West Group	100			89[134]
Southwest Group		125	25	50
North Group			95	255
South Group	—	—	—	210
	100	125	120	604
Lockheed[135]				96
				700

National orders and national work distribution broke down in the following percentages:[136]

	Orders[137]	Work
FRG	63.6%	39%

Italy	13.2%	21%
Netherlands	12.6%	18%
Belguium	10.5%	22%

As is readily apparent, German industry received less than its proportional share. This was due to the fact that in the beginning of the program, the FRG's factories still lacked adequate production capacity. In addition there was the necessity of German concessions so as to provide the other nations with sufficient incentive to undertake the joint project; the FRG wanting to have the weapon system project associated with NATO, and not as a German one.

For engines however, the FRG was allocated the assembly of the largest number, BMW supplying the engines for both the North and South Groups. The other two engine assembly lines were at Fabrique Nationale in Belgium and Fiat in Italy. Though these three firms all carried out final assembly and testing, they otherwise had a closely integrated manufacturing effort with minimal duplication elsewhere in the process.[138] As such each of the three firms was simultaneously prime contractor as well as sub-contractor of each other two. Production of an initial 1,369 General Electric J-79 jet engines was agreed for allocation as follows:

General Electric (USA)	- 144 engines
BMW (FRG)	- 627 engines
Fabrique Nationale (Belgium)	- 334 engines
Fiat (Italy)	- 264 engines

(Further orders were made as the program progressed)

LICENSE PRODUCTION OF THE PRINCIPAL ELECTRONIC SYSTEMS

SYSTEM	LICENSE FROM	EUROPEAN MANUFACTURER
Inertial Navigation System	Litton	Litton GmbH, FRG.
Fire Control and Navigation radar	Autonetics	Telefunken, FRG; HSA, Navigation Radar Netherlands; MBLE, Belgium, FIAT, Italy
Automatic Flight Control System	Honeywell	Honeywell GmbH, FRG
Navigation Computer	Computer Devices of Canada	Teldix, FRG
Air Data Computer	Air Research	Interaero, FRG
Bomb Timer	Lear	Lear GmbH, FRG
Launch Distance Com-	General Electric	AEG, FRG

puter and Optical
Sight

TAGAN	IT & T	Standard Elektrik Lorenz, FRG
Infrared Sight	Lockheed	Eltro, FRG; Oude Delft, Netherlands
UHF System	Collins of Canada	Van der Heem, Netherlands
IFF System	Hazeltine	Siemens & Halske, FRG

Source: Interavia

For electronics, there were 11 principal systems. Though not fully reflected on the chart on the previous page, among these seven systems were produced jointly by seven different multi-national industrial teams, while for the four remaining systems production was entrusted to four separate firms, each being the sole supplier for all four air forces for the given system.

As with the engines, in those cases where production involved duplication, each company would make certain parts of the equipment, while receiving other parts from the other manufacturers for final assembly.[139]

As a matter of principle, every attempt was made to have all airborne electronic equipment produced within the European consortium in line with the

repartition of the overall program. In practice, however, this proved to be difficult to accomplish and the production of certain equipments had to continue to come from the U.S. and Canada well into the program, for the following reasons:

- some of the systems were not fully developed and ready for series production.

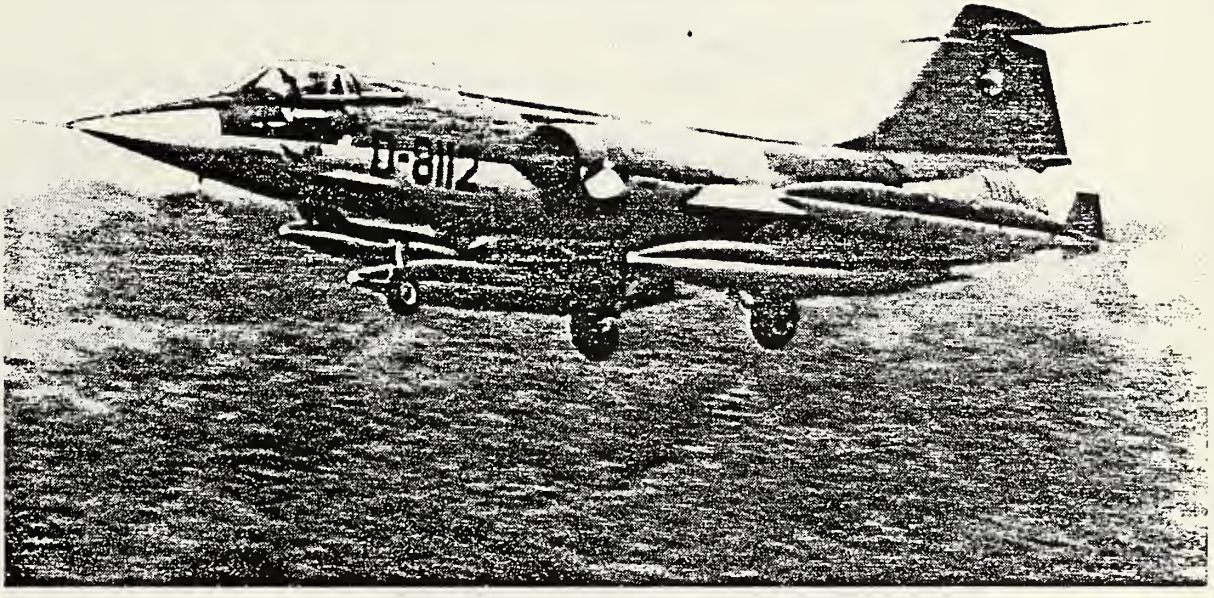
- due to the aircraft having been selected before all necessary license-agreements were negotiated, the consortium's position was not too strong, resulting in unreasonable demands with respect to license-fees, royalties, etc., from U.S. firms.

- European firms required large investments for expanded capacity in tooling, testing, training, etc.

- Some of the European industries encountered a lack of cooperation on the part of U.S. system designers in the early phases.

By the third phase of production planning complete European production was attempted. As is often the case in such licensed production projects, initial delivery requirements could not have been achieved if all the parts were to be of European manufacture from the beginning.[140]

Royal Netherlands Air Force: RF-104 Starfighter



Source: NATO's Fifteen Nations

In addition to the $145 million in aid provided by the U.S. government in the form of U.S. material and technical assistance, an estimated $800 million in direct purchases were made by the consortium from the U.S., bringing the value of the U.S. industrial share to almost half that of the total program.[141]

Not only did Lockheed provide 28 to 30 technicians to work in NASMO itself but the company also set up a separate Advisory Office in Koblenz near NASMO. The Advisory Office assisted in all matters ranging from close cooperation on requirements for subcontractors, to negotiations on manufacturing costs and production matters.[142]

Over 150 Lockheed employees were abroad for much of the program. When General Electric, and the U.S. Electronics firms representatives are added, the total number of technical assistants becomes a sizeable one.[143]

As aptly summed up in the U.S. DOD testimony at the House Hearings on Foreign Operations in 1965, page 496, "The main purpose of the F-104G Program was to enable the consortium countries to develop their technology and to participate more aggressively in the NATO defense."

5. Contractual, Price, and Audit Aspects

Under NASMO's control, a total of about 125 major contracts were finalized between the purchasing governments and the manufacturers. Since, in 1960 most of the F-104G weapon system was still in the developmental phase, the

industries could not arrive at reliable prices. Nevertheless, the master Agreement called for concluding contracts on a fixed price basis, subject to escalation for salaries and raw material.[144]

A way out of the dilemma was found by the use of "letters of intent," at first, and then by concluding preliminary contracts which fixed a ceiling price, subsequently followed by definitive contracts. Thus it was possible to start production and to make advance payments. Firm contracts followed later.[145]

As the concluding of the preliminary contracts and the negotiation of the definitive fixed price contracts promised to be a long and difficult operation, initially, letters of intent had to be relied upon. This allowed the firms to get started immediately; i.e., those participating firms that were directly involved in license negotiations could negotiate and sign the agreements; as well as order tooling and long-lead raw materials.

The preliminary contracts that would finance the initiation of production were offered to industry in return for their consenting to the following conditions:

- a ceiling price (in most cases being that of licensor) below which the final firm-fixed price would have to fall,

- a delivery schedule from which was established a financing schedule;
- termination clauses:[146]

- a method of establishing the firm fixed price that would be applicable in case of an impasse being eventually reached over the supplier's final proposed offer (following a full accounting of the estimates provided by its internal pricing systems).

> "These preliminary contracts foresaw monthly payments limited on the one hand by a justification of expenses and on the other hand by the finance plan. At first this method worked well, but the laborious finalizing of successive preliminary contracts resulted in uncovered funding deficits for individual firms that were often dangerously large."[147]

In spite of a commitment of the contracting parties to rapidly conclude firm fixed price contracts, negotiations were long and difficult, which necessitated a renewal of the preliminary contracts every two or three months. In the opinion of Regout, this was the weak point of the system.

For the preparation of finalized contracts the four participating governments had adopted a procedure comprised of three steps:

- drafting a standard guide for all program contracts entitled, General Terms and Conditions for Procurement Contracts Under the F-104G NATO Starfighter Production Program;

- the negotiation of definitized contracts based on the above guide, but adapted to the particular case, i.e., national regulations and practices;

- the presentation of a detailed estimate by the contractor with a proposed contractual price, the elements of which would be the object of often in depth auditing of accounts after which would be adopted a formula for revision of the price, one composed of several parameters and a system of financing.

In the words of Andre Regout:

> Through negotiation after negotiation, by patience and tenacity, several contracts reached the end of this long administrative trek. To my knowledge, only 4 contracts out of a total of 62 are at this moment signed (April 1964), those of Fokker, Messerschmitt, Fabrique National and Oude Delft.148

The 62 principal contracts with the 21 program prime contractors were divided up as follows by the four governments:

	Airframe	Engine	Avionics
FRG	4	3	14
Italy	1	1	11
Netherlands	2	2	11
Belgium	1	1	11[149]

Andre Regout of Fabrique Nationale ascribed the difficulties with regards to timely signing of the contracts to three principal points.

> First of all, there's the cumulative slowness of four national administrations. Secondly, the total opposition of the customer governments to gather around one table all those firms concerned with a given element of the aircraft, in order to discuss the text of the preliminary contract of the definitive contract. Thirdly, the ponderousness of the auditing of costs for a given firm due to verification in minute detail and the frequent absence of accurate statistics.

On this last point Regout felt a well reasoned bargaining process would benefit both parties more than an in-depth audit of costs within the factory.[150]

Andre Regout relied on the experience of the F-104G engine group, and Fabrique Nationale (FN) in particular, as an example of the sequence of events described below. In June, 1960 FN received a letter of intent from the Belgian MOD. It was not until 10 months later that this letter of intent was succeeded by the preliminary contract, and then another 18 months were required before the definitive contract could be signed. Each of the three member firms of the engine group had to begin one by one the whole contractual process as its national government opted to join the program. The signing of FN's definitive contract followed that of BMW by 18 months, and Fiat's was expected to follow FN's by another 21 months at least.[151]

General Robert Bureau, the Belgian representative on the NASPO BOD, and later Director General of NAMSA countered Regout's position as follows:

> It has often been said that the awarding of contracts was the 'point noir' of the F-104G program. On this point, for example, the final firm contract with the temporary grouping SABCA-Fairey was not signed until the beginning of 1965, while a fair number of aircraft coming off this line had been flying for some months. I have come to the conviction that this reproach ignores the philosophy of the system. Indeed, firm prices can only be established when production is sufficiently advanced. If one takes into consideration the inevitable slowness of the audit of accounts and negotiations (without a doubt excessive in our case) one must admit that one cannot avoid the late signature of firm contracts.152

Orders were placed in accordance with an agreement on so-called "territorial principles." This meant that each government acted as host country, i.e., preparing the contracts for firms located within its boundaries, following one of two methods:

(1) Drafting and signing a contract as the host country on behalf of other governments;
(2) Preparation of the contract by the host country, but allowing actual signing to be done by each separate government.

Method (2) was finally used for most cases to avoid prefinancing by one government on behalf of the others, and because it avoided certain export and tax problems.[153]

> This method of having contract clauses prepared by the host country on behalf of all other participating countries, proved to be very satisfactory. The retention of cognizance by each nation's own procurement service to negotiate with its own national industries was thus preserved, and at the same time the member governments actually signed separately after the negotiation phase, thus preserving their prestige and "sovereignty." NASMO coordination of this basic phase of contracting resulted in earlier contractual coverage, greater uniformity, and a savings in negotiating man power. Indications are that this is one of the better methods that can be adpoted to obtain the advantages of built-in governmental machinery and expedite the negotiation phase. In summary, observers generally agree that the decision to entrust contract arrangements to host countries on behalf of the other members should be a feature of future programs.154

In the initial phases of the program, there was a lack of uniformity in the terms and conditions of individual contracts. NASMO and the Consortium Governments set up a working group which drew up detailed procedures for

contracting in the standard guide entitled, General Terms and Conditions for Procurement Contracts Under the F-104G NATO Starfighter Production Program. Although this guide proved to be of lasting value, it wasn't without it problems.

Since the initial text had been established unilaterally by the customer(s), the document had to be revised a number of times at the request of industry. In May 1963, in its sixth edition it was able to obtain the approval of all concerned, definitively. These successive modifications of terms and conditions obviously complicated contractual negotiations.[155]

One of the common conclusions reached by those reviewing the program were that general terms and conditions for contracts should be established as soon as feasible. The primary purpose was to avoid precontracting and letters of intent if possible, as well as to avoid lengthy contract negotiations. The reviewers concluded that general terms, once set, should be required as the base for all tenders received from manufacturers.[156]

On one point though, having originally agreed that only fixed type contracts should be concluded, the parties found it impossible to finalize them during the first several years. Instead, they agreed to a ceiling price which was to be set as low as possible, but under no conditions higher than comparable U.S. prices. Eventually, a final fixed price agreement between governments and manufacturers was reached for all contracts, although in many cases resort had to be made to independent, third party calculations.[157]

The governments agreed that audit of price and cost calculations should be performed by the host nation's own service responsible for such price investigations and evaluation. Representatives of the combined governments were authorized to observe investigations and evaluation. If orders were in excess of $50,000, and were placed with U.S. firms, the U.S. Air Force plant representative examined the price. This practice proved successful and resulted in several price reductions to the benefit of the Eurpoean purchasers. The U.S. provided this service at no cost, based on an agreement between the USAF and NASMO.[158]

6. Infrastructure and Logistics

Much as the NATO Hawk program had its counterpart in the NATO Infrastructure Program for the construction of SAM ground sites, the F-104G had its counterparts in such areas as airfields, aircraft shelters, and more specifically in command and control.

It is one thing to possess high performance versatile aircraft that can intercept, reconnoiter, and bomb, such as the F-104G. However, to carry out effective air defense, the F-104G, like all supersonic aircraft, requires a sophisticated system of ground control radar, computers, and communications to direct the aircraft on its missions. SHAPE had been engaged for a number of years in designing just such an air defense system, one to be paid for out of NATO Infrastructure Program funds. The F-104G helped bring this concept to fruition.[159]

The highly controversial and uncertain history of planning for the much needed common control system was finally resolved shortly after the introduction of the first F-104G's into the air forces of the four Alliance members. Earlier, after SHAPE had finally come up with the international control system, the NATO Air Defense Ground Environment (NADGE), the United States rejected it as too elaborate and costly when the plan was presented for approval early in 1963.[160]

The American veto caused indignation in Belgium and the Netherlands, because as they saw it, the United States had enticed them into buying a weapon, the F-104G, dependent on ground control, and then had blocked the construction of the necessary system to control it. The impasse was eventually resolved when the United States accepted a less costly plan, and NADGE construction finally got underway[161] (see Chapter 3).

In 1965 the NATO Maintenance and Supply Agency (NAMSA) set up its second operational center, the Koblenz Procurement Center (KPC). The KPC was formed to provide procurement support to the F-104G Weapon System Partnership consisting of those NATO countries possessing the F-104G aircraft. This included the four consortium countries of Belgium, the FRG, Italy and the Netherlands plus three U.S. MAP recipients, Denmark, Greece and Turkey. The KPC was closed down in 1976 and F-104G parts are now procured by the NATO Supply Center in Capellen, Luxembourg.

7. Lessons Learned

a. The Cornell Study

The less-than-favorable conclusions that were developed in the Cornell paper regarding the F-104G were summarized as follows:

(1) Delivery schedules originally did not fully take into account all the conflicting factors of joint production; nor did they take into consideration a proper balance of these factors.

(2) Full interchangeability checks were not carried out between components as soon as the first ones were produced.

(3) The aircraft specifications, at least in basic configuration, were not considered in due time.

(4) The requirements for aerospace ground equipment were not established early enough to insure delivery with the aircraft.

(5) An efficient repair scheme was not established from the start to preclude shortages of parts and equipments being diverted later from production to necessary repairs and vice versa.

(6) General terms and conditions for contracts were not established soon enough to avoid the practice of precontracting and issuing of letters of intent.

(7) A U.S. Weapon Systems Manager was provided rather late. His arrival took place when the program was well advanced. He was not available during earlier critical phases when he was most needed.

"The above summary principally reveals technical and timing lessons, problems that were similar in cause to the other conclusions on the debit side. These are important, but can be remedied if STARFIGHTER and other joint ventures are used as examples."[162]

In summing up the creditable facets of the project Cornell cited the following points:

—Quality control, while a difficult task, especially for the United States for those parts made in America, was well organized and carried out.

—Interchangeability checks, while late, showed good adherence to production specifications.

—Technical Documentation, a colossal job in itself, was well done. Updating of documents left something to be desired in the beginning until given to one responsible group to control.

—Pricing and audit of price calculations, as well as preparation of the contract clauses, were left to host countries and successfully

performed by them, especially considering the extreme difficulties faced in arriving at firm prices, due to the developmental nature of the F-104G.

—General terms and conditions for contracts should be established as soon as feasible, as the basis for all tenders in order to minimize the use of letters of intent and avoid lengthy negotiations.

—Security was made easier by the use of NATO procedures covering personnel and classified matter.

—Deliveries were subject to some extreme "highs and lows" in their production profiles, but still were completed in the five year time frame originally envisaged and in many cases were made prior to the readiness of Air Forces to receive and use them.

—Modification and Configuration control, colossal tasks at the very least, were placed under uniform procedures and control, thus holding detrimental effects on production and delivery schedules to a minimum.

—Spare parts requirements were foreseen early, but funding, understanding of usage, contracting and production problems did not permit adequate provisioning or concurrent delivery in many instances. The conclusion was reached that spare parts provisions must be included in every original production contract.

—Phasing out was performed well, considering the lack of retention control any organization has over its employees in the final stages when faced with dissolution. Had the NASMO been made up of career people, i.e., was made up of personnel from segments of existing government organizations, the problem might have been avoided.[163]

b. The James and Vandevanter and Regout Studies

According to R. R. James, the principal lesson is that there is a vital difference between common production of an existing, proved weapons system and one that is still under development; participating countries should be extremely cautious about getting involved in such projects.[164]

Vandevanter found the F-104G project history to be illustrative of the following three points:

(1) If concensus formation within the BOD is not rapid enough, the imperatives of managing an integrated program can force a General Manager of the international project office into a position where he has little choice but to stretch the limits of his authority, (and at considerable risk to himself).

(2) Contrary to what one is often led to believe, NATO projects do not originate from either brilliant internationalist schemes, nor from insidious plots,

but from successful protracted bargaining among a varying mix of interested national governments and/or firms.

(3) Substantial benefits accrue to those inter-allied weapon system projects that assume the NATO label, with regards to:

- authorization of funds;
- taxes and tariffs;
- dealing with classified data;
- priveledges granted personnel, and;
- such political benefits as alliance solidarity.

Regout offered, among others, the following conclusions as worthy of keeping in mind in the organization of future programs:

(1) It is desirable to negotiate simultaneously all license agreements for each end-product (i.e. electronic subsystems, engine and air frame), instead of having each licensee negotiating in a dispersed manner.

(2) Along the same lines, in order to accelerate the conclusion of future contractual negotiations, it is necessary to negotiate simultaneously all contracts covering a given end-product through the intermediary of an inter-governmental organization bestowed with the power of decision making.

(3) As for the organization of industry a complete and well designed organization must be set up prior to a launching of the production program. However for the F-104G, the urgency of the requirement led to a greater preoccupation with an initiation of production and cost, as opposed to organization. This empiricism led to the industries involved setting up a simple organization which permitted them to operate in a flexible and efficient manner, while offering the advantage of avoiding the slow breaking-in process of a new organization. The results were satisfactory but one might say the empirical approach went a bit too far and would not necessarily be best for future programs. In Regout's opinion the structure of the European Prime Contractor for the Hawk project, SETEL would be better, with the condition that it substituted for the several national prime contractors, several technical prime contractors i.e., instead of dividing up responsibility along geographic lines, follow a technically based division.

C. THE NATO BULLPUP AND SIDEWINDER MISSILE PROJECTS OF THE EARLY 60's

In the cases of the Bullpup and Sidewinder production programs, neither project was of the scale or technological intricacy of the $2 billion F-104G program or the $667 million Hawk program. Unlike the two larger projects, with Bullpup and Sidewinder one firm acted as the prime contractor, with all other firms participating as subcontractors.

The Sidewinder program cost some $25 million to the US and the eight participating countries: Belgium; Denmark; the FRG; Greece; the Netherlands; Norway; Portugal; and Turkey. The Bullpup program amounted to somewhatover $40 million, shared by the US and the four participating countries: Britain; Norway; Denmark; and Turkey.[165]

The Sidewinder was chosen by the eight nations over the British Firestreak and a French competitor, both of which were claimed as superior by their respective nations and selected for their own armed forces. The Bullpup was chosen by these four nations over its major competitor the French AS-30 missile. The AS-30 was selected not only by the French as one might expect, but by the FRG as well. German selection of the French system over the competing American system in this one case could well have been influenced by the need the FRG feels to balance their collaborative relationships, especially after the selection of the F-104G over the Mirage II.

The Sidewinder project was launched in 1959 and its NPLO charter was approved by the Council in January 1962. The Bullpup project was launched in 1961 and its charter was approved in May 1962. The Sidewinder project was formally ended on 31 December 1965, by which time well over 5,000 missiles has been delivered. The Bullpup project was completed in mid-1967, by which time over 4,000 missiles had been delivered.[166]

In both projects, the amount of work to be done in each participating country was calculated in proportion to its requirement. In the case of Sidewinder, with eight participating countries, this resulted in a very complicated production-sharing arrangement. In the case of Bullpup, it was a simpler problem involving only four countries, but Britain and Norway had substantial differences between the value of their investments in the project and the nature of the work secured.

Both projects experienced delays and rising costs. The final deliveries of Sidewinder were nearly a year behind the original schedule; Bullpup, after a slow start, did a little better than this. Problems arose in each case over the inadequacy of some of the subcontractors, but these were all solved by the respective NATO Production and Logistics Organizations (NPLO's) working closely with the prime contractors. The most serious disruption evidently arose over the allocation of the prime contractorship for the Bullpup program, the failure of one participating country in one of the projects to meet its financial obli-gations to the project for three years, and a lack of proper coordination between licensor and licensee, again involving Bullpup. Both of these projects emphasized the difficulty of including member-countries whose

technological and industrial resources were inadequate for a sophisticated weapons system. When such a country has a substantial financial investment in the project, it becomes difficult to provide it with its proportionate share of work. It is worth noting, in any case, that in both projects some subcontractors in participating countries with ample technological resources failed to meet quality requirements.

1. The NATO Bullpup Project

The Bullpup program involved a major dispute over the prime contractorship. The British proportion of production was 65.5 percent, whereas that of Norway was 15.75 percent. The cost to the British was estimated at $22,254,000; that to Norway $5,185,000. The British were to provide the motor, the warhead and much of the structural work. The Norwegian participation was limited to the assembly of the nose and the manufacture of the gyroscope. Despite the logic of the numbers, the Norwegian Government took a very strong line about securing the prime contractorship, and it eventually won out. The prime contractor was Kongsberg Vapenfabrikk of Oslo, and therefore the corresponding NPLO was established in Oslo. As emphasized by Robert R. James,

> There is no doubt that the British had an overwhelming case for having the prime contractorship, and it is to be hoped that in the future this issue can be avoided. Not only is it unfair but it is clearly inefficient to have a prime contractor whose country's contribution to a project is of such a small proportion, unless there are overwhelming technical considerations.[167]

Another problem area of the Bullpup project concerned the exchange of technological information. Considerable difficulty was experienced in building the igniter in Britain. It was discovered only after several months that the specification and requirements of this vital part of the system had been modified in the United States after similar difficulties had been experienced. This could have been easily avoided by the presence of a representative of the licensor at the NATO Project Office to keep it up to date.[168]

The United States provided $6.5 million in reimbursable aid for the Bullpup which amounted to 704 missiles at a cost of $9,233 each (the cost to European purchasers was $10,370 per missile).[169]

Only five NATO countries (i.e. including the U.S.) purchased Bullpup. The FRG, with similar requirement for an air-to-ground missile, chose and jointly produced the competing French AS-30 missile. The AS-30 also received sponsorship as a NATO project. German industry acted as subcontractors to developer, Nord Aviation (now part of Aerospatiale) for production. Though producing the Bullpup, the UK also later bought the AS-30 from France.

2. NATO Sidewinder Project, AIM-9B

Through the NATO Sidewinder project, aircraft of the majority of the NATO nations were fitted with a version of the Sidewinder air intercept missile (AIM), the AIM-9B. The first Sidewinder, AIM-9A, was developed in the early 50's at Naval Ordnance Test Center (now known as Naval Weapons Center), at

China Lake, California. Under the guidance of the Naval Weapons Center, the system progressed through a series of design updates, starting with AIM-9B in the mid-50's. The Naval Weapons Center took the position of lead in the development of these evolving Sidewinders, receiving industrial support from various companies. The European version of the Sidewinder was modified by the German licensee, the NATO Sidewinder program's prime contractor, Fluggeraetewerke GmbH (FGW) (now known as Bodenseewerk Geraetetechnik).[170] In order to adapt the USAF version of the Sidewinder, the AIM-9B, to the peculiar weather conditions in Europe and to the displacement of air combat to lower altitudes, FGW modified the seeker head. This version of the missile was given the designation AIM-9B FGW Mod. 2.

The Sidewinder ad hoc mixed working group held its first meeting in January, 1959. The Sidewinder was the second, after Hawk, of the series of the multi-national licensed production projects that were launched between 1959 and 1963. The NATO Sidewinder Production Organization was established following a Consul resolution of December 9, 1959 but as with its Hawk counterpart—its legal status was not yet clarified. The Board of Directors (BOD) held its first meeting seven weeks later in January, 1960, electing a president and a general manager.

Vandevanter cited the Sidewinder project in contrasting it with official NATO procedures embodied in C-M(59)82 which were launched the same year as the NATO Sidewinder Program, 1959. Whereas C-M(59)82 emphasized organization and proce-dure, the description of the Sidewinder experience provided by the

Assistant for Missile Production, Production and Logistics Division of the International Staff, Don R. Ostrander, in the December 1959 issue of NATO Letter stressed the concept of NATO as an "honest broker" who concentrates on the problem of securing the agreement of two or more of the nations for a given project.[171]

In the case of the first two of these Mode #2 projects - Hawk and Sidewinder - both launched in 1959, it is important to point out that the International Staff was more active than the later F-104G, Mark 44, and Bullpup projects. In the flurry of allied activity that followed the 1957 Sputnik launch, the International Staff was authorized to draw up information on a number of weapons, from which national representatives could select several for pooled production. Ostrander's description of this process as it applied to the Sidewinder project, is as follows:

> Because the NATO countries are co-equal partners, independent to make their own decisions, the initiative must come from them. The Missile section (of the Production and Logistics Division of the International Staff) acts as a focal point and a catalyst — with only the power of persuasion to get agreement on a given programme through negotiation and compromise —both of which require infinite patience.
>
> The steps in getting joint production started were fundamental; first, the job was to provide the various nations with information on the kinds of missiles available so that they could decide which ones best fitted their military requirements. This was done through a series of briefings and conferences as well as circulation of documents followed by individual discussions and exhibits....If several nations became interested in a particular weapon, the military and technical specialists were formed into a working group....First on the agenda is the necessity to determine total combined requirements for the weapon.... After the requirements are established the working group tries to select one nation --generally the one with the greatest requirement --as the "lead nation' and

> within that nation a firm generally is designated as prime contractor for the weapon system....This prime contractor then subcontracts with the firms in other countries --usually designated by the participating nations themselves.172

The governmental organization involved the usual BOD, consisting of the representatives of the eight participating governments, plus one from the U.S. (who, through MAP, was also a procuring government). Under the BOD was its executive organ, the NATO Sidewinder Program Office headed by the general manager, and charged with the day-to-day management of the program and acting on the BOD's behalf. The Program Office was set up in the FRG at the site of the prime contractor. The staff of the Program Office never exceeded a total of 20.

Since the Sidewinder program was faced with the same impasse as the Hawk program regarding the interpretation of the 1951 Ottawa Agreement, the organization's juridical status remained in the air for some time. It was not originally recognized as a subsidiary body of NATO, and thereby participating in its legal personality. This resulted in an excessively cumbersome relationship with the prime contractor, Flugeraetewerke GmbH (FGW), involving the sending of identical copies of any agreements or contracts to each government for their signatures. This awkward state of affairs continued for a while until it was finally decided to convert the Organization into an agency under common law so that one person could act in the name of several, provided that all were in agreement. This proved to be a much easier way of handling things, except that the power of attorney had to be requested from the governments for the president of the BOD and the general manager each time

that a contract had to be signed, even though an agreement had been reached in the BOD.[173]

As always an administrative agreement (more recently known as MOU's) covering the intergovernmental obligations regarding program implementation was negotiated between the member states. The agreement covered regulations relating to price control, auditing, payment, quality control, and so forth. The FRG assumed responsibility for paying all advances ad interim.[174]

In its first annual report the BOD stated that:

"In light of the present experience, the effectiveness of an organization of this nature would be considerably increased by the recognition of the organization as a subsidiary organization of NATO."[175]

Finally, after yet another year had passed, the Consul established the Sidewinder organization as a subsidiary body of NATO on February 26, 1962, and approved a charter. The charter was one modeled along the lines of NATO's recently approved Model NPLO Charter (C-M (62)18).

Mr. M. K. Halsne, previously President of Sidewinder BOD and the Norwegian representative, felt that although there were considerable problems with the accumulation and transmission of American know-how, those major difficulties encountered were of the same type and of the same scale as those which one might expect from any program of equivalent technological complexity.[176]

In addition to the prime contractor and 11 subcontractors from nine nations, a total of some 250 firms were engaged in the program (excluding manufacturers of raw materials).[177] At the beginning of the program the prime contractor was asked to negotiate and conclude the necessary agreements for the purchase from the U.S. of privately held patent rights. This contract was then submitted to the BOD for approval. NATO was the owner of those proprietary rights transferred from the U.S. Government (as part of U.S. Government assistance). It was decided that it would be best, in the case of any future production based on the same patents, to keep all such rights in the hands of one entity. As such the prime contractor, Fluggeraetewerke, received title to all government held patents, as the agent of the NATO Sidewinder Program's BOD.[178]

In concluding on the Sidewinder project, Halsne felt that ignoring the considerable spinoffs in the form of know-how, and in spite of the contracts being cost-plus-percentage of cost, the cost of the missile was comparable to those produced in the U.S. for the same volume of production. He also felt that it was generally understood that establishment of an NPLO brought considerable advantages in not only providing a legally recognized entity heading up the program, but one that avoided any negotiations over custom duties and tariffs—an area in which the Sidewinder program had had difficulties in the beginning.[179] One other point Halsne made considering the BOD is the following:

> An important problem, I feel, is the BOD. The members of this consul must be able to abandon their national and professional

behavioral norms. And if they are tempted by perfectionism, may they only remember that 'le mieux peut etre l'ennemi du bien.'180

3. The Bullpup and AIM-9B Projects—Lessons Learned

(1) Though the concern for allowing the smaller nations an occasional lead role in multi-national projects is a valid one, this is not an acceptable alternative for any given project in which the larger nations participate, as is almost always the case. This is due to overwhelming considerations of 'juste retour,' as well as efficient management and utilization of allied resources. Since the proposal for a planned specialization along national lines has been so poorly received (for good reasons), the only vehicle available for ever allocating such a lead role to the smaller nations would have to be limited either to subsystems or possibly one system within the framework of a 'Family of Weapons.'

(2) The Bullpup project also serves to remind us of the need to establish and maintain effective communications between licensor and licensee.

(3) Though R. R. James wasn't specific as to which of these two projects was the one concerned, one of the participating nations was seriously delinquent in meeting its financial obligations. There is always a need in multi-national projects for some mechanism to deal with this possibility (e.g., governmental quarantees to the contractor, or an agreed to interest charge for the resultant financing involved).

(4) Halsne emphasized the importance of the milestone in the evolution of allied collaboration represented by the approval of NATO's Model NPLO Charter (C-M(62)18) in 1962, and its contribution to the efficient administering of multi-national projects.

(5) Halsne also brought out the ever present need to maintain vigilance vis-a-vis the attitude adjustment required of all individuals participating in such projects.

(6) Though not without its problems, both of these projects serve as examples of the ability of the less developed southern members of the Alliance to participate in these projects. Not only is this a possibility, but a requirement for future projects as we enter the 1980's.

(7) Such missile projects, from amongst all the expensive high technology systems lend themselves particularly well to collaboration for several reasons:

(a) the nature of the lower end of the aerospace/electronics industry—which involves much of the work of these projects—requiring limited capital investment and allowing for production on a smaller scale, and;

(b) the number of units involved allows for longer production runs; both of which mean there is smaller premium involved in duplication and fragmentation of the production effort.

(8) Both the initiative and decision-making authority for all NATO projects rests solely with the nations. However, NATO international staff/secretariat can still serve in a vital role as focal point and catalyst for collaboration, if so allowed.

D. THE SECOND WAVE - THE EARLY 80's

1. Sidewinder AIM-9L

In October, 1977 the U.S. and the FRG signed an MOU that would eventually lead to a consortium to produce the new AIM-9L Super Sidewinder under license in Europe. It was announced in January, 1978 that the FRG was to build 9000 AIM-9L's for its own use. The UK, Italy and Norway have since decided to participate in the joint production effort as well. It is expected that the missile will be widely adopted for those European nations in both the F-16 and MRCA consortia.

This project represents the first use made of Mode #2 in over a decade, as well as involving a unique backup arrangement that allowed for the elimination of a competing system.

a. The U.S. Program

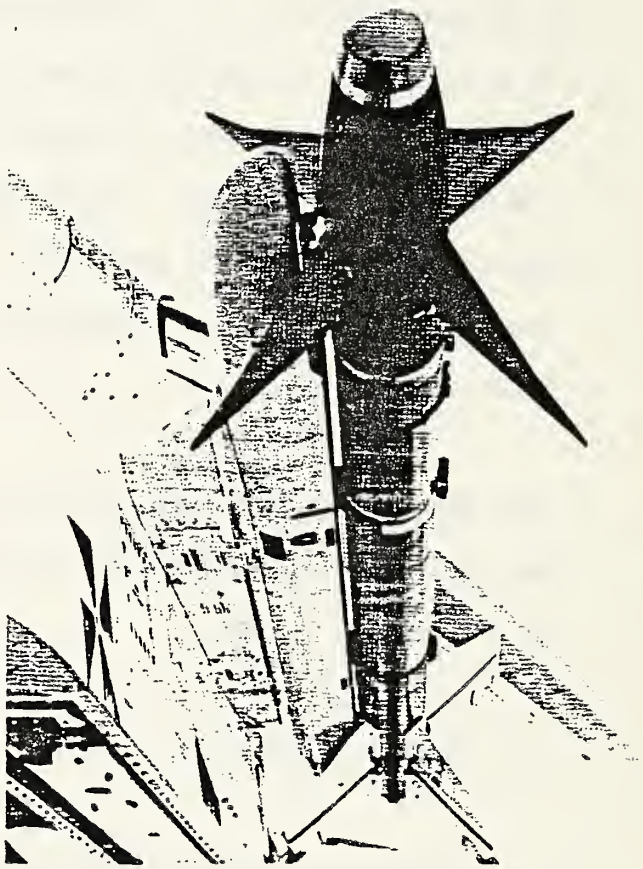
With the evolution of technology the Sidewinder has continued to grow in its capability to meet expanding Air Warfare requirements while maintaining the missile's fundamental design concept and guidance method. The AIM-9L is the sixth generation version of this family of short range, infrared air-to-air missiles, having been preceded by the AIM-9A, AIM-9B, AIM-9D, AIM-9G and AIM-9H. The main improvement introduced in the AIM-9L over earlier models is its all-aspect capability enabling it to acquire and track targets from

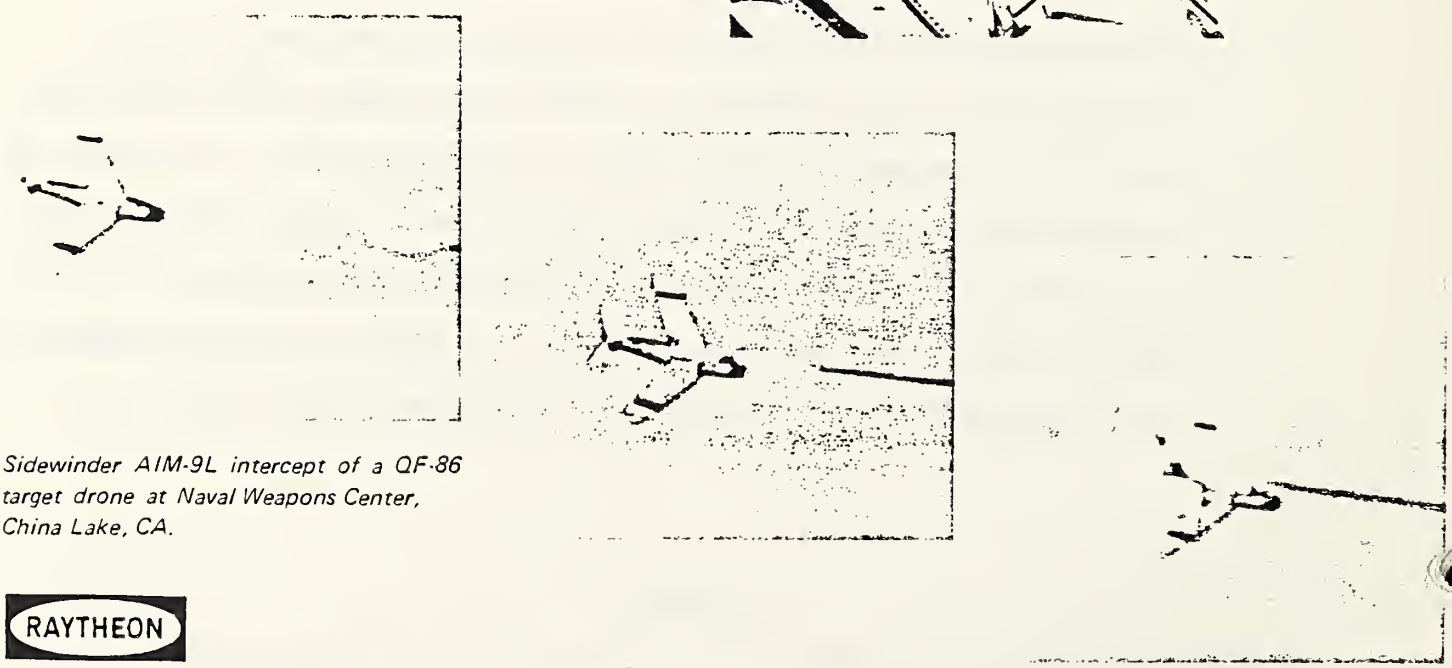
RAYTHEON'S SIDEWINDER AIM-9L... ALL ASPECT CAPABILITY

The Sidewinder AIM-9L is the free world's most advanced, short range, infrared air-to-air missile. It is a sixth generation all solid-state version of the earlier AIM-9A, AIM-9B, AIM-9D, AIM-9G, AIM-9H missiles and is in production under a joint U.S. Navy/U.S. Air Force program. Employing a passive infrared seeker, AIM-9L has increased forward aspect capabilities over earlier models of the missile. It is configured for easy installation on a wide range of modern, tactical aircraft including the F-18, F-16, F-15, F-14, F-4, F-8, A-4, A-6, A-7, and the vertical takeoff Harrier OV-10.

With a record of demonstrated combat effectiveness, the Sidewinder missile is characterized by:

- High Reliability
- Low Per-Round Cost
- Simplicity (requires no aircraft avionics or radar)
- Minimal Size, Low Drag and Weight
- Adaptability (can be easily rail-mounted on virtually any type aircraft or helicopter)





Sidewinder AIM-9L intercept of a QF-86 target drone at Naval Weapons Center, China Lake, CA.

RAYTHEON

head-on as well as from the tail chase position.[181] The U.S. prime contractors for production are Raytheon and Ford Aerospace, which were to build some 14,950 AIM-9L's through 1982 for the USAF and the USN.[182] The German licensee, which will also be the prime contractor for production in Europe, is once again Bodenseewerk Geraetetechnik GmbH (formerly FGW) that served in the same capacity for the previous NATO Sidewinder (AIM-9B) program. Raytheon is supplying services, test equipment, and some components to the European consortium.

Development of the AIM-9L began back in January, 1971 at the Naval Weapons Center (NWC) with a joint Navy-Air Force program to modify and upgrade the AIM-9H Sidewinder. Late in the same year, Raytheon was selected as the industrial support contractor to assist NWC in the development of the AIM-9L.[183]

Raytheon's role in the various Sidewinder projects goes back to 1964 when it was selected as a second source for the AIM-9D. Subsequently, Raytheon produced the AIM-9G, AIM-9H, and the MIM-72A (a surface-to-air version of the AIM-9D used in the Army's Chaparral air defense missile system). Among the various firms having provided industrial support to the NWC in the development of the different versions of the Sidewinder deployed, Raytheon had worked as the support contractor for guidance control systems on the AIM-9H and AIM-9L.[184]

Following the completion of TECHEVAL and OPEVAL, authorization was given to proceed with production of the AIM-9L. Raytheon was awarded the initial

low-rate production contract in April, 1976. Successful completion of first article testing and follow-on operational test and evaluation programs resulted in a release to full-rate production for the AIM-9L in early 1978. An alternative source, the Aeronutronics Division of Ford Aerospace Communications Corporation began delivery of production AIM-9L guidance and control sections in early 1979.[185]

Additionally Raytheon is currently support contractor to the NWC for the joint USN-USAF development program for the latest version of the Sidewinder, the AIM-9M.

The AIM-9M is designed to have improved performance in counter measures and back-ground environments over the AIM-9L. The ninth consecutive successful flight test of the new AIM-9M took place in June, 1979, at China Lake. Raytheon is providing industrial support to the NWC in the development of the missile's guidance control system. The company is currently working under an $8 million development contract which includes a 50-unit pilot production run for test programs.

b. The NATO Program—Failure of Early Initiatives

Going back to the NATO program's origins at the end of the '60's, concept studies were carried out in the UK, France and the FRG aimed at fulfilling the requirement for a next generation air-to-air missile. Despite the fact that the basic requirements were similar, efforts through NATO's Conference of

RAYTHEON'S SIDEWINDER AIM-9L...
ALL ASPECT CAPABILITY



Specifications

Length:	2.9m (113 in.)
Diameter:	0.12m (5 in.)
Wing Span:	0.63m (25 in.)
Canard Span:	0.4m (22.3 in.)
Weight:	86 kg (190 lb)
Guidance:	Passive Infrared
Warhead:	10.15 kg (25 lb)
Fuzing:	Proximity and Contact
Launcher:	Rail

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National Armament Directors (CNAD), one of armament its subordinate groups, the NATO Air Force Armament Group (NAFAG), and elsewhere, failed to combine these national concept proposals into one single development. Consequently, the three nations went ahead independently to develop their own systems: the Viper (FRG); the Matra R550 (France); and the Taildog (UK).[186]

The U.S. as well, continued with its own concept studies for the next generation missile, based on the same requirements as the Europeans, and with similar objectives.

With the problems caused by escalation in the cost of development of defense material receiving increased attention in the early 70's, CNAD's task of coordination and rationalization was eased somewhat. This led to renewed attempts to increase collaboration, including air-to-air missiles. However, at this stage combined development was no longer possible and any standardization would have had to result from selection among the four national designs of the U.S., UK, France and the FRG.[187]

It was then agreed among the national armaments directors that one system would be selected which would be carried to completion on a national basis, with the other partners being granted license production rights for subsequent manufacture.[188]

Here, we came to the usual impasse that follows efforts to organize a competitive common selection among the procuring nations' own systems—one

where there is a need to agree on the method of evaluation, the criteria to be used, as well as following through with a commitment to abide by the final decision. The U.S. armaments director proposed holding competitive firing trials to determine and select that system with the best performance. This was unacceptable to both the FRG and the UK since their programs, the Viper and the SRAAM75, were several years behind the U.S. and French development programs, the MATRA R550, and the AIM-9L. The FRG, which (lacking any suitable test zones on its own territory) had been forced to resort to system simulation so as to reduce the necessary test firings to a minimum, proposed that the selection take place using system simulation techniques. For the U.S., though, with its China Lake, California development center where live firing trials were the principal test method, this German proposal was unacceptable. Consequently there was no follow through on the agreement for a competitive common selection, and the four national development programs continued.[189]

c. From a Unique Bilateral Agreement to a NATO Program

In spite of the above coordination and rationalization setbacks, an independent series of events did eventually lead to the German Viper and British SRAAM75 development projects being discontinued by their respective national governments. Here, we'll cover in detail only the series of events that finally led to a bi-lateral solution allowing the FRG to adopt the AIM-9L.

But first, the British, for whom the reaching of a decision to discontinue its SRAAM75 effort, was a much less complicated affair. The British had decided unilaterally to drop the SRAAM75 and continue only with a low key technology effort. The alternative originally chosen was to buy the AIM-9L directly from the U.S., but once the FRG had decided on the AIM-9L as well, and the European production of it, the British decided to procure primarily from the European production line; one that would include British firms.

As a result of an internal evaluation carried out by the German Government it was eventually concluded that, in light of the comparative tactical evaluation of both missiles, together with the evaluation of the costs of development, procurement and integration, the availability timescale, and the cross-servicing capability, continuation of the Viper program was no longer justified, despite the investment already put into the program. Besides the inevitable weaknesses of any such evaluation process, gathering data on the AIM-9L by the FRG at first proved difficult, since the two systems under evaluation were competitive. High level pressure was eventually required before this barrier could be overcome.

But even with the knowledge that the AIM-9L was the preferable system, two serious complications still stood in the way of an abandonment of the Viper program. First, although the AIM-9L development pushed steadily ahead with every indication that it would be successfully concluded, the U.S. could not guarantee, at that time, that the system would enter service with the U.S. armed forces.[190] Secondly, the abandonment of the Viper project at such an

combine the seeker head of the Viper with the other components of the AIM-9H (i.e., the existing Sidewinder with the highest performance). The result was an outstanding missile concept with extraordinary system performance which even surpassed AIM-9L performance in certain areas.193

Consequently, this missile was designated Sidewinder-Alasca (All Aspect Capability). As such, with the Sidewinder-Alasca, a concept was found which, in the event of the AIM-9L program being dropped, could be used as a backup. The Viper program could finally be suspended. In addition, such a system would allow for interchangeability and interoperability. In case of premature termination of the AIM-9L program, the Sidewinder-Alasca program was in reserve, one which could be pushed ahead with American assistance.[194]

Schenk further noted one other advantage of the AIM-9L being adopted by the Europeans.

The simple modular design lends itself well to the subcontracting of components in other countries. An example is Norway, already a partner in the German Viper development program, which will join the new program and take over production of the rocket motor, as it did for the first NATO Sidewinder program.195

d. The Industrial Consortium

In mid-May 1979 the FRG and Norway were joined by the UK and Italy -the FRG's two partners in the MRCA consortium. With BGT as licensee and prime contractor, the work-sharing agreement reached by the four countries is as follows:

- Warhead—50% of the work to be done by SNIA Viscosa (Italy) (mechanical parts + final assembly) and 50% by MBB (FRG) (charge);
- Engine—the British Royal Ordnance Factories will produce the tube, while the rest will come from Raufoss (Norway);
- Wings and rollerons—from British Aerospace;
- Guidance & control section—BGT (FRG) will provide some parts and perform final assembly;
- The cryostat will come from Hymatic (UK);
- the IR sensor from AEG-Telefunken (FRG);
- the gas generator from SNIA Viscosa (Italy);
- IR proximity fuze—will be US Government furnished equipment (GFE).[196]

The value of the work done in each country will fall roughly in proportion to each nation's planned order. As of late 1979 the national orders from the European production line totaled 8,800:[197]

FRG	5,500	62%
UK	2,500	28%
Norway	500	6%
Italy	300[198]	4%

The other three European F-16 consortium members besides Norway -Belgium, Denmark, and the Netherlands - have encountered budgetary problems,

having spent so much on the F-16, that they feel they can't currently afford new armament, and are therefore continuing to rely on older missiles. There is still a possibility they may enter the European consortium, but this is becoming more difficult with time.

In addition to license production, the FRG has also contracted to buy its first 2 years' requirement of AIM-9L's outright. Except for the optical fuze, the U.S. government had agreed to release to the FRG the entire AIM-9L data package. The fuze is considered a "first line" item, the U.S. Navy being particularly anxious about letting the fuze data out of the country.[199]

Both Raytheon and Ford Aerospace have signed purchasing agreements with BGT involving the selling of test equipment, technical assistance, and so forth.

e. Several Issues Faced

There has been a two year slippage in the start of the European production line. This slippage resulted from a sequence of unexpected delays, and led to an erosion of the European line's original order base, followed by the usual round of recriminations, as well as the dissipation of some expected problems.

The Luftwaffe needed the AIM-9L by a certain date and the consortium's schedule was originally geared to meeting it. U.S. development problems delayed the program initially, however. Then there was slippage over the finalizing of intra-European production arrangements, which were in part the result of the U.S. government's slowness in agreeing to modify the MOU with the FRG to allow for release of technical data to those partners that joined at a later time—there being some concern over Italy[200]. As a result of these delays, the FRG had to buy its first, and later its second, years' requirements from the U.S., instead of the European production line as originally planned.[201]

As one might expect, there were some recriminations emanating from the European side of the Atlantic over the impact of these slippages on their their order base. This involved accusations that Raytheon and Ford were doing best to impede a timely transfer of data. Though not true, one invariably hears such things in any such highly visible interdependent venture involving so many parties.[202]

A second point over which there were some bad feelings in the FRG was the Memorandum of Agreement concerning the AIM-9L, signed in 1974 by the U.S. and the FRG. The Germans considered it an MOU, while the U.S. did not. The actual MOU wasn't signed until some three years later in 1977.[203]

An issue that initially aroused some uneasiness on the U.S. side was the timing of the transfer of technology. Back in 1974, when discussions

with the Germans were becoming more concrete, the AIM-9L was still under development in the U.S. Certain operations personnel were opposing the transfer of technology at an early stage in the system's life, as originally envisioned. For some, the ghost of the AIM-9B incident (involving the stealing of one of the missiles from a Luftwaffe base and its delivery to the Soviets) was especially haunting.[204]

In any event, as it turned out, the 2 year slippage in the start up of the European production line had two positive side-effects. One, by the time the first missile comes off the European production line in early 1981, U.S. production of the AIM-9L will be approaching its end, thus lessening the sensitivity of the security issue. Secondly, at the time the data was to be originally transferred, the AIM-9L was still at an early point in its production in the U.S. and as such did not yet have a mature data package. Consequently, the problems normally emanating from a fluid configuration were avoided.[205]

Therefore, although the multi-lateral, alliance-wide solutions to the next generation air-to-air missile that the national armaments directors attempted to reach within CNAD were never implemented, the bi-lateral US-FRG solution that was eventually worked out, is serving as a focal point around which other allied nations are able to collaborate. Thus the current generation of short range air-to-air missiles for the NATO members will involve only two instead of four missiles—the AIM-9L and the MATRA R550.

This is allowing for greater standardization, and possibly interoperability as well. Although this program is relatively small, it is one more link contributing to the present effort to revitalize the Alliance through having found an economical, yet militarily and politically acceptable solution to NATO's RSI problems. This program is also the first in what hopefully will be a second wave of European multinational license production projects involving U.S. developed systems. This time around though, the renewed utilization of this Mode will be interdependent with the U.S. eventually adopting more European developed systems through either direct purchase, or more likely Modes #4 and #8. The British Harrier and Franco-German Roland systems were the only two major European systems introduced into the U.S. inventory during the 1970's. Both had very rough going in the U.S. Congress during 1979.

f. AIM-9L-Lessons Learned

(1) This project history provides yet another example of the futility of organizing a competition leading toward common selection among procuring nations each of which has its own system at stake.

(2) When the allied nations show the will and persistence to collaborate, NATO's existing procedures for cooperation in the R&D and production of armaments provide an effective mechanism for promoting RSI.

(3) This NATO program provides an example of the creativity and unique arrangements that are not only possible, but will be required of future NATO programs. This one allowed for the cancellation of one of two duplicative allied systems, while maintaining both nations R&D efforts, and a back-up alternative.

(4) It portrays some of the implications of the interdependence between, and sequencing of, two parallel allied production programs with regards to the development schedule, timing of technology transfer and their ramifications vis-a-vis security as well as maturity of the data package, sharing of orders, and taking on new members.

g. Conclusion

Even though the program is built upon a compromise that involved a rather unique set of circumstances, it is representative of the results obtainable when the strength of commitment to the goals of NATO RSI leads to such unrelenting efforts as those displayed by the German and American armament directors, Herr Wahl and Dr. Currie.

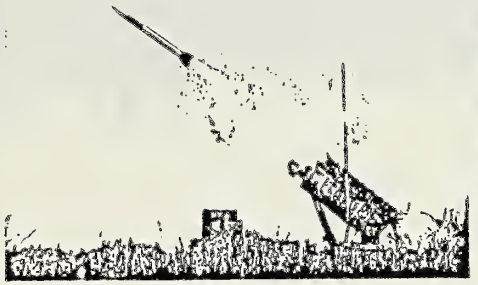
The size of this second swell in Mode #2 will in part depend on the success of the U.S. in implementing Modes #4 and #8 in furtherence of the "two-way street" policy, by increasing the production under license in the U.S. of European developed systems. As shown by the difficulties of the AIM-9L program, unlike the previous wave of such programs that began

in the late 50's and early 60's, the FRG is now more often in a position to offer its own competing programs. Its situation is now somewhat akin to that of the UK's and France's in the earlier period, one which accounted for in good part their minimal participation in the previous wave of Mode #2. So once again we see that the frequency of use of one Mode will in the future be interrelated with that of several other Modes.

2. Patriot

A significant follow-up to the Sidewinder AIM-9L program in the second wave of Mode #2 could be a program involving the license production in Europe of the Patriot surface-to-air missile as a replacement for the NIKE Hercules. Set up in late 1978, a NATO working group consisting of Belgium, Denmark, the Netherlands, and Greece (who signed an MOU in October, 1978), began exploring the most suitable acquisition options for a NATO Patriot project. France and the FRG joined several months later, upon their signing the MOU in February. The effort of reviewing the total acquisition process and reaching an agreement on a NATO Patriot Acquisition Option was expected to last 2 years and be terminated by October, 1980. This will then be followed by another MOU covering implementation of a NATO Patriot Acquisition Program for Europe. The UK was again not participating, as with the NATO Hawk, because of its decision to continue with its own system, the Improved Bloodhound.[206]

Patriot: the air defense system of tomorrow that's in production today.



Patriot's high performance missile utilizes sophisticated track-via-missile (TVM) guidance.

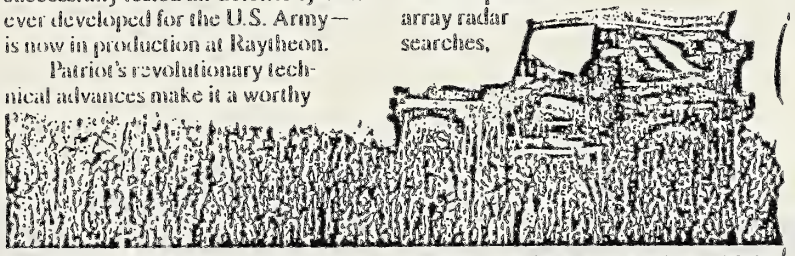
Patriot—the most thoroughly and successfully tested air defense system ever developed for the U.S. Army—is now in production at Raytheon.

Patriot's revolutionary technical advances make it a worthy successor to the Raytheon-developed Basic Hawk and Improved Hawk systems that have been the mainstay of effective air defense for the U.S., NATO, and other friendly nations for more than two decades. It has demonstrated the firepower and ECM performance needed to handle advanced threats for the balance of this century...and into the next.

The system repeatedly proved itself against multiple threats that employed a wide variety of electronic counter measures and evasive maneuvers. Additional tests will be conducted in parallel with initial production.

Fast reaction times and great accuracy.

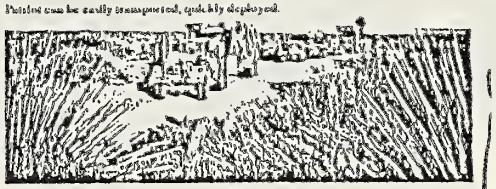
Several advanced features contribute to the system's exceptional performance. To achieve extremely fast reaction times, Patriot's phased array radar searches, detects, identifies, and tracks multiple targets simultaneously. And to ensure great accuracy, the system's high-performance missile utilizes track-via-missile (TVM) guidance that combines the advantages of command guidance and semiactive homing. TVM enables Patriot to deal with the most difficult high-speed targets, even at low altitudes.



Extensively tested for proven effectiveness.

Fully integrated for battalion operation and under software control, Patriot has undergone an exhaustive series of developmental and operational tests.

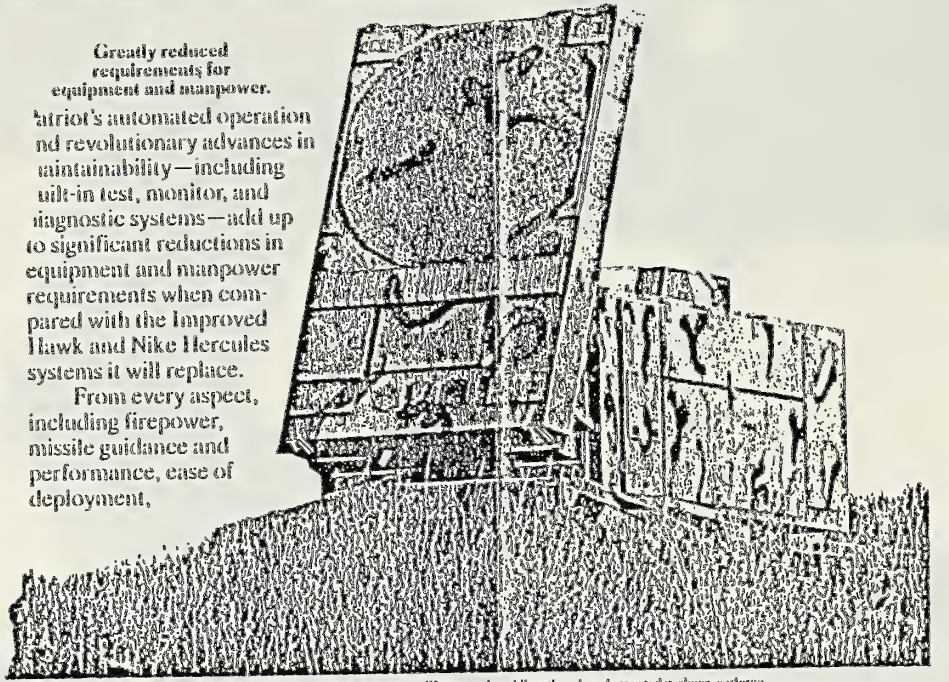
Patriot can be easily transported, quickly deployed.



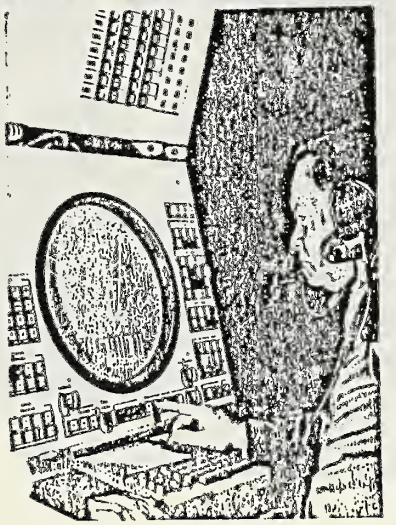
Greatly reduced requirements for equipment and manpower.

Patriot's automated operation and revolutionary advances in maintainability—including built-in test, monitor, and diagnostic systems—add up to significant reductions in equipment and manpower requirements when compared with the Improved Hawk and Nike Hercules systems it will replace.

From every aspect, including firepower, missile guidance and performance, ease of deployment,



The system's multifunction phased array radar, above, performs all tactical functions that, in present systems, require several separate radars. Below left, one of only two operators needed for system operation.



manpower requirements, and maintenance, Patriot marks a new era in air defense.

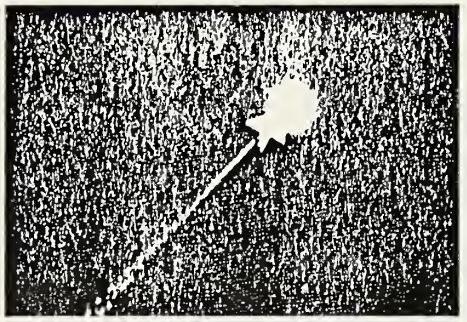
For additional details on the Patriot system, write on your letterhead to Raytheon Company, Government Marketing, 141 Spring Street, Lexington, Massachusetts 02173.

RAYTHEON

See Patriot at the 1981 Paris Air Show, Stand No. 47

Circle Number 193 on Reader Service Card

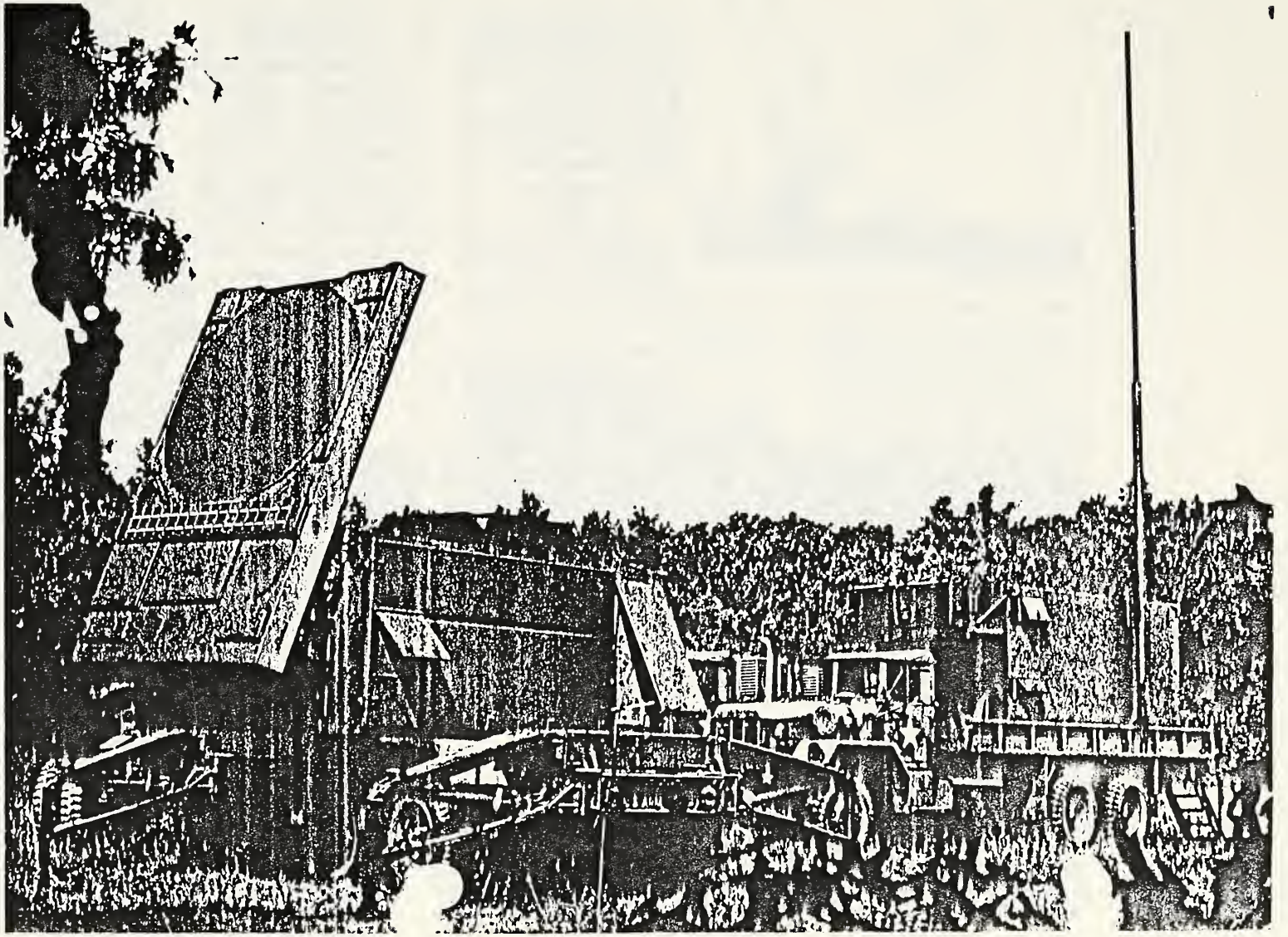




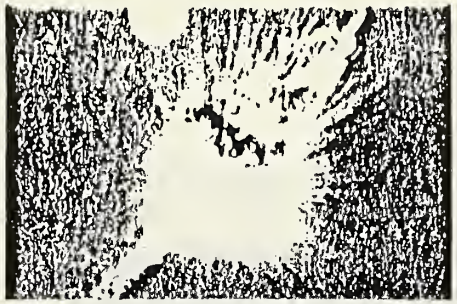


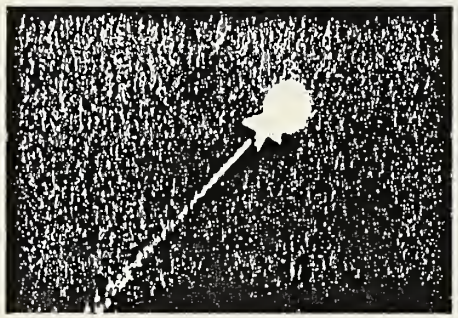
PATRIOT...

air defense for the 1980's

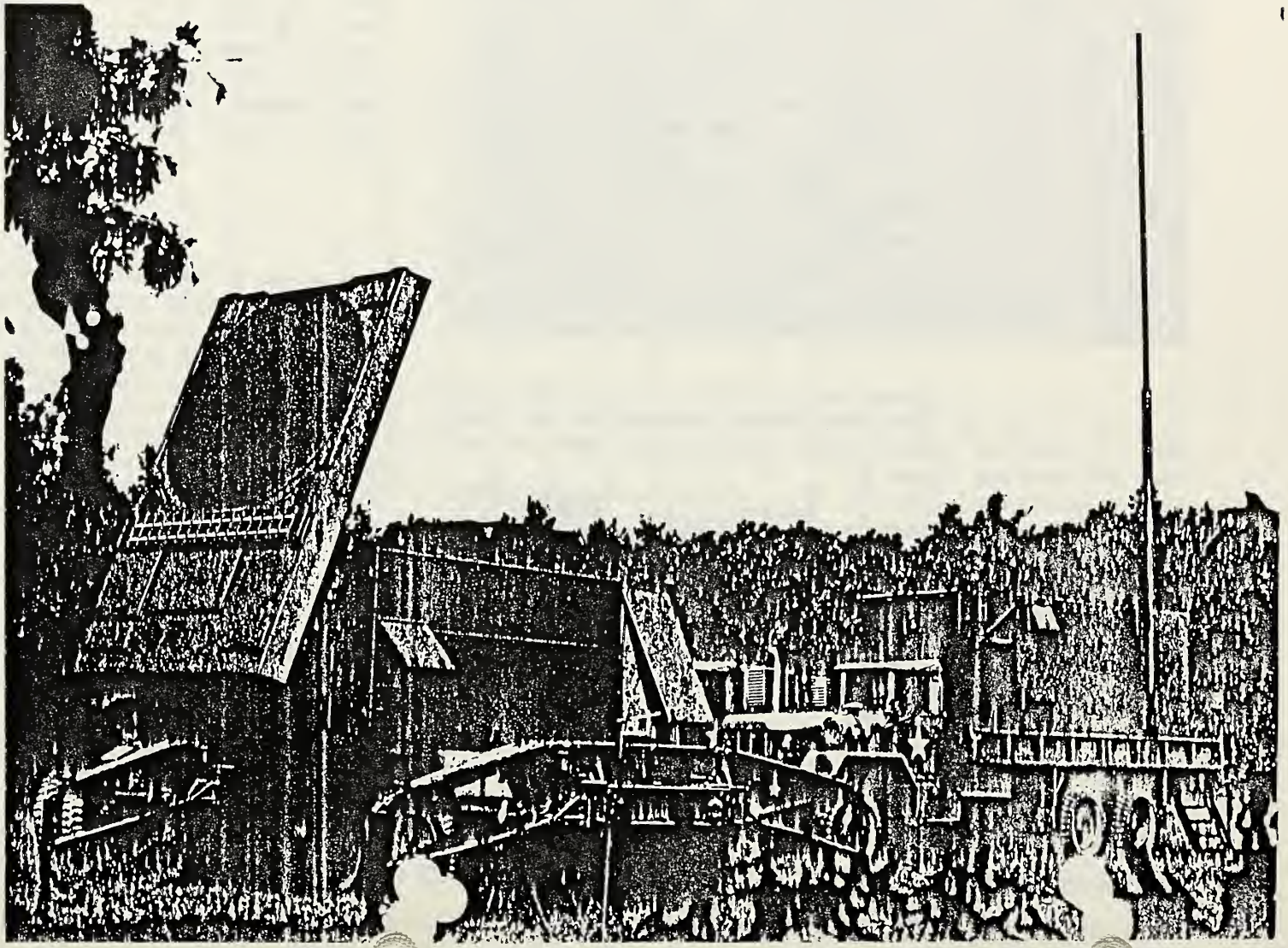


PATRIOT...
air defense for the 1980's









The PATRIOT Air Defense Missile System is designed for maximum effectiveness against the air threat anticipated in the 1980s and beyond. Specifically, the system's fast reaction capability, its high firepower, and its ability to operate in a severe electronic countermeasure environment are features not available in presently operational systems but necessary for adequate air defense.

The basic operational unit of the PATRIOT System is the Firing Platoon consisting of a Radar Set, an Engagement Control Station and several remotely located Launching Stations.

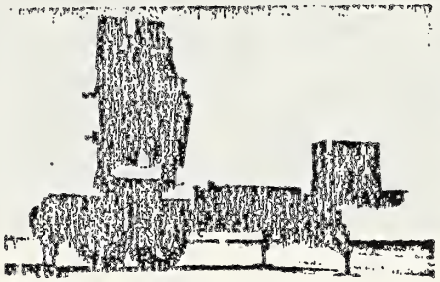


The Radar Set is . . .
a multifunction, phased array unit providing for all the tactical functions of airspace surveillance, target detection and track, and support of missile guidance. The combination of computer control and phased array technology enables the time sharing of functions so that the performance workload of this single radar is equal to that of the nine different radar types used in present day systems.

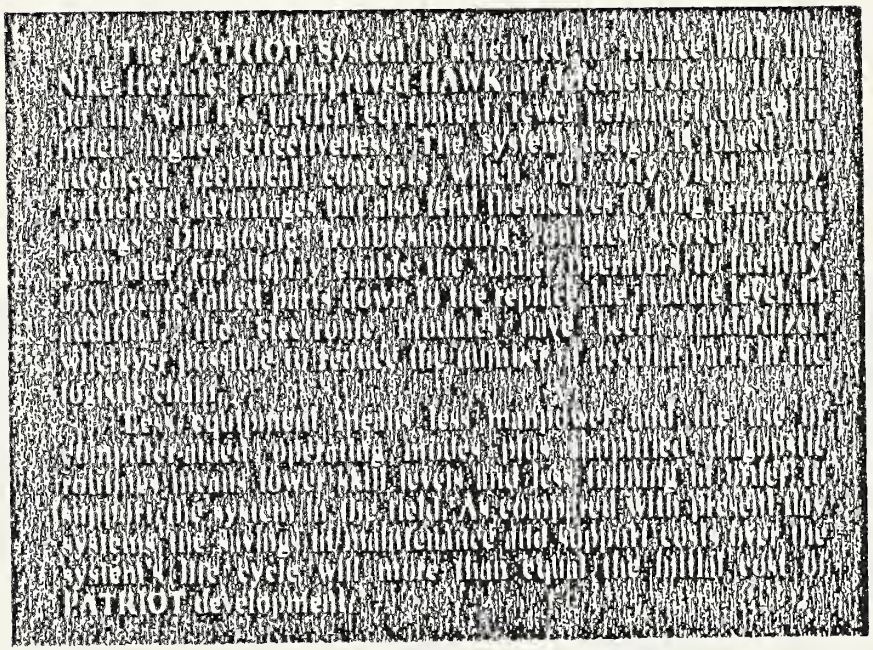
The Engagement Control Station . . .



houses the system's two operators and contains the weapon control computer plus two tactical display consoles. The software-controlled computer exercises authority over all tactical operations including radar scheduling, weapon assignment, missile launch, and intercept assessment. Operating modes vary from a computer-aided manual mode, to semi-automatic, to a fully automatic mode with the operators always retaining full override capability of computer decisions.



The Launching Station . . .
is a mobile platform containing a cluster of four ready-to-fire missiles. Each missile is sealed into a canister which serves as both a shipping container and launch tube. In a tactical environment, the Launching Stations (normally five but possibly eight) are widely dispersed and communicate with the Engagement Control Station via secure RF data links. This non-clustering of equipment makes the system difficult to detect and thus increases battlefield survivability.



a. The System

The highly mobile, all-weather Patriot missile system will be the cornerstone of field army air-defense against medium-to-high-altitude targets during the 1980's and beyond. Raytheon is prime contractor for development and production to the Army Missile Research and Development Command's (AMRADCOM) Patriot project office in Huntsville, Alabama. Martin Marietta Aerospace is Raytheon's principal subcontractor.

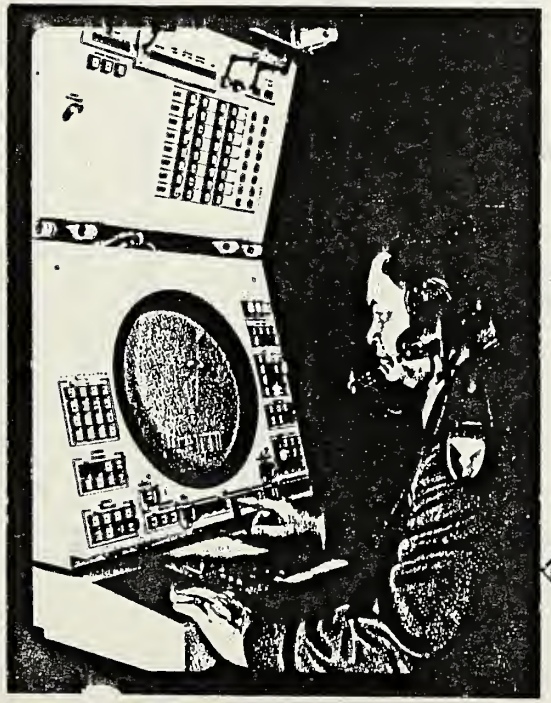
The Patriot air defense system is scheduled to replace both the NIKE Hercules (high altitude) and the Improved Hawk (medium altitude) for the U.S. Army. Patriot will replace these systems with not only much higher effectiveness, but with less equipment and fewer personnel. The first production run start up was in early 1980. Designed for maximum effectiveness against the air threat anticipated in the 1980's and beyond, the system's fast reaction capability, its high firepower, and its ability to operate in a severe electronic countermeasure environment, are required features for adequate air defense not available in those systems that are currently operational. Less tactical equipment results in a need for less manpower, while the use of computer-aided operating modes, plus simplified diagnostic troubleshooting routines, means lower skill levels and less training are required to support the system in the field. As compared with those systems operational in the late 70's, the savings in maintenance and support costs over the system's life cycle will more than equal the initial cost of the Patriot's development.[207]

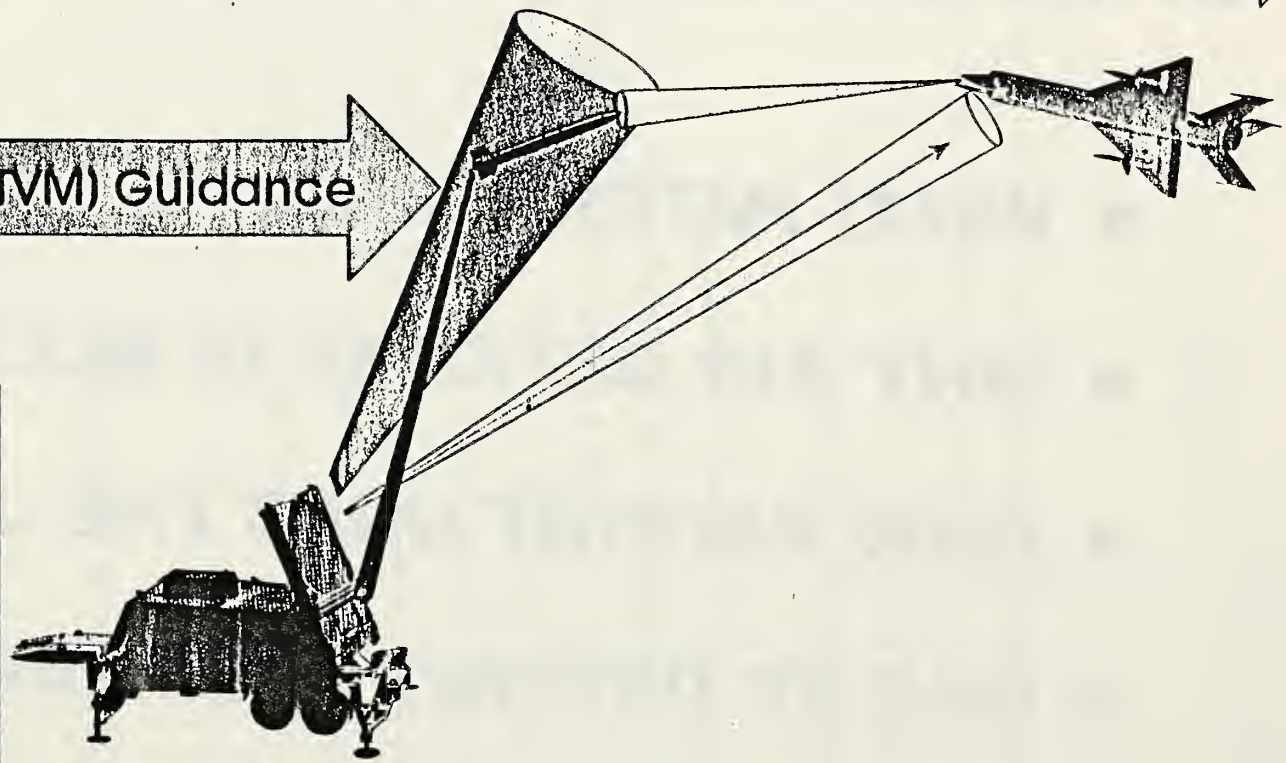
WHAT PATRIOT IS....

the essence of PATRIOT is....

Multifunction Phased Array Radar

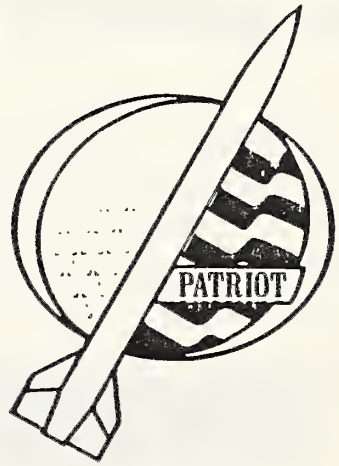
Track Via Missile (TVM) Guidance





Automated Operation with Human Control

in this book....



- ***WHAT PATRIOT IS....***
- ***WHY AIR DEFENSE IS NEEDED....***
- ***HOW PATRIOT DOES THE JOB....***
- ***WHERE PATRIOT IS TODAY....***

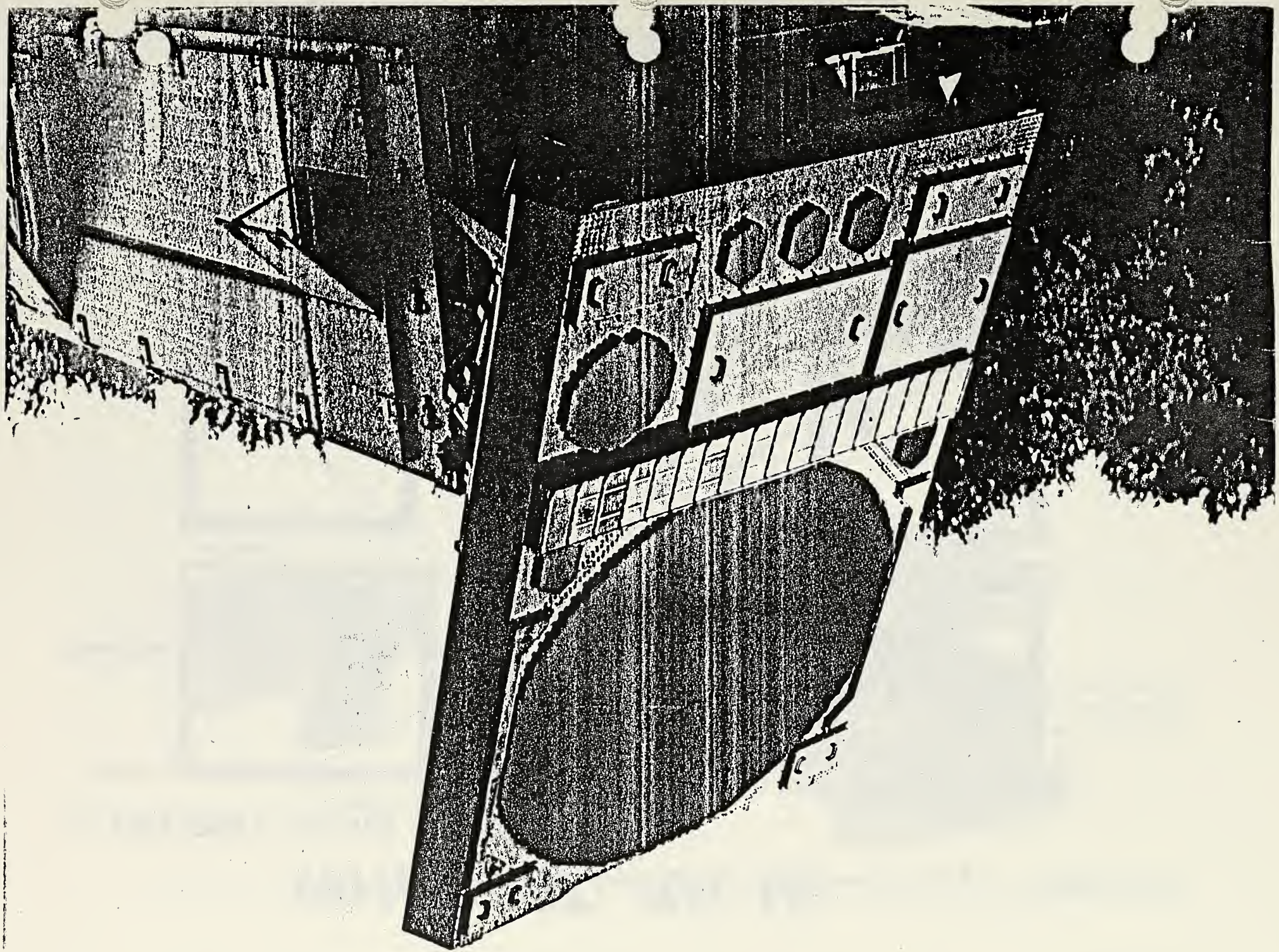
The basic operational unit of the Patriot system is the firing platoon consisting of the following truck or trailer mounted elements:

- a radar set;
- an engagement control station;
- an electric power plant supplying power to the two above elements, and;
- several remotely located launching stations.

b. From a Bi-lateral, to a NATO Effort

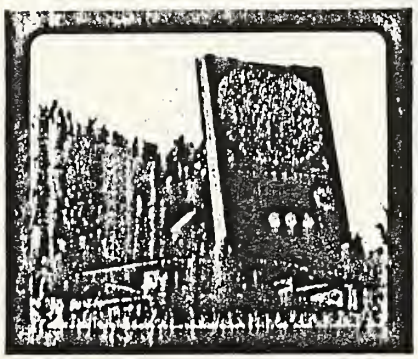
As with the F-104G and AIM-9L before it, the NATO Patriot program evolved from an initial bi-lateral U.S.-FRG agreement. The NATO working group consists of a Program Steering Committee (PSC) composed of high level representatives of each nation and a full time management group of 21, the NATO Patriot Management Organization (NAPATMO), located in Munich. The current study is a follow on to Project Successor, a German-U.S. Study concluded in early December, 1977 which evaluated the Patriot system's suitability for a European air defense role. The Army Missile Research and Development Command conducted this study for the DOD along with its German counterpart.[208]

The establishment of the PSC and NAPATMO had been preceded within NATO, by CNAD's establishment of two NATO Project Groups. One examined the replacement of NIKE Hercules, a high altitude SAM in the European inventories, by Patriot. The other studied Patriot, among other systems, as a replacement for Improved

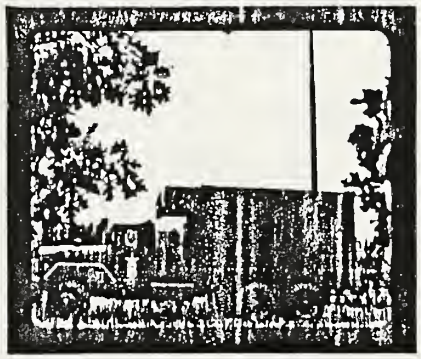


WHAT PATRIOT IS....

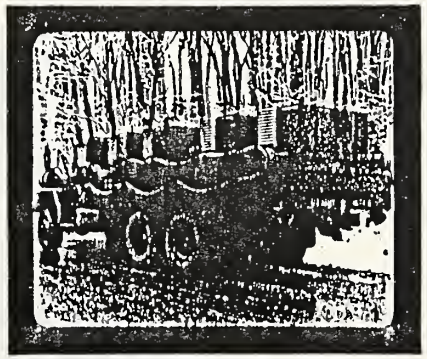
a PATRIOT firing platoon is....



Radar Set



Engagement Control Station



Electric Power Plant



Launching Station



Launching Station



Launching Station



Launching Station



Launching Station

PATRIOT system operation



Supplies Electric Power
for Engagement Control
Station and Radar Set

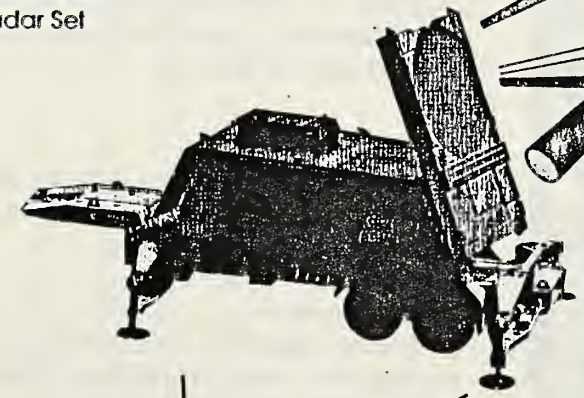
Missile Track
Command Uplink

TVM Track

TVM Downlink
Missile Status

Target Track & TVM Illumination

Surveillance and Detection



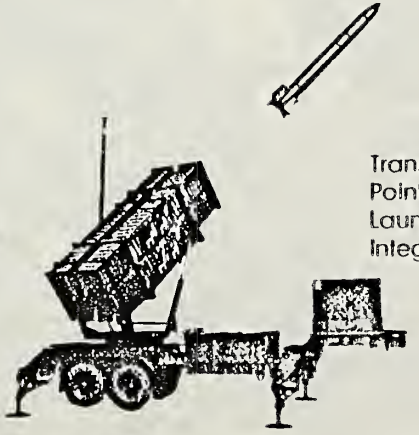
Searches
Detects
Identifies
Tracks
Illuminates
Communicates with Missile

Targets to be Tracked
Missile Firing Alert
TVM Guidance
Priorities



Monitors Readiness
Threat-orders
Gives Priorities to Radar
Determines ECCM
Computes Guidance Commands
Provides Human Interface
Communicates with Battalion Headquarters

Launcher Pointing
Missile Prelaunch Data
Firing Signal

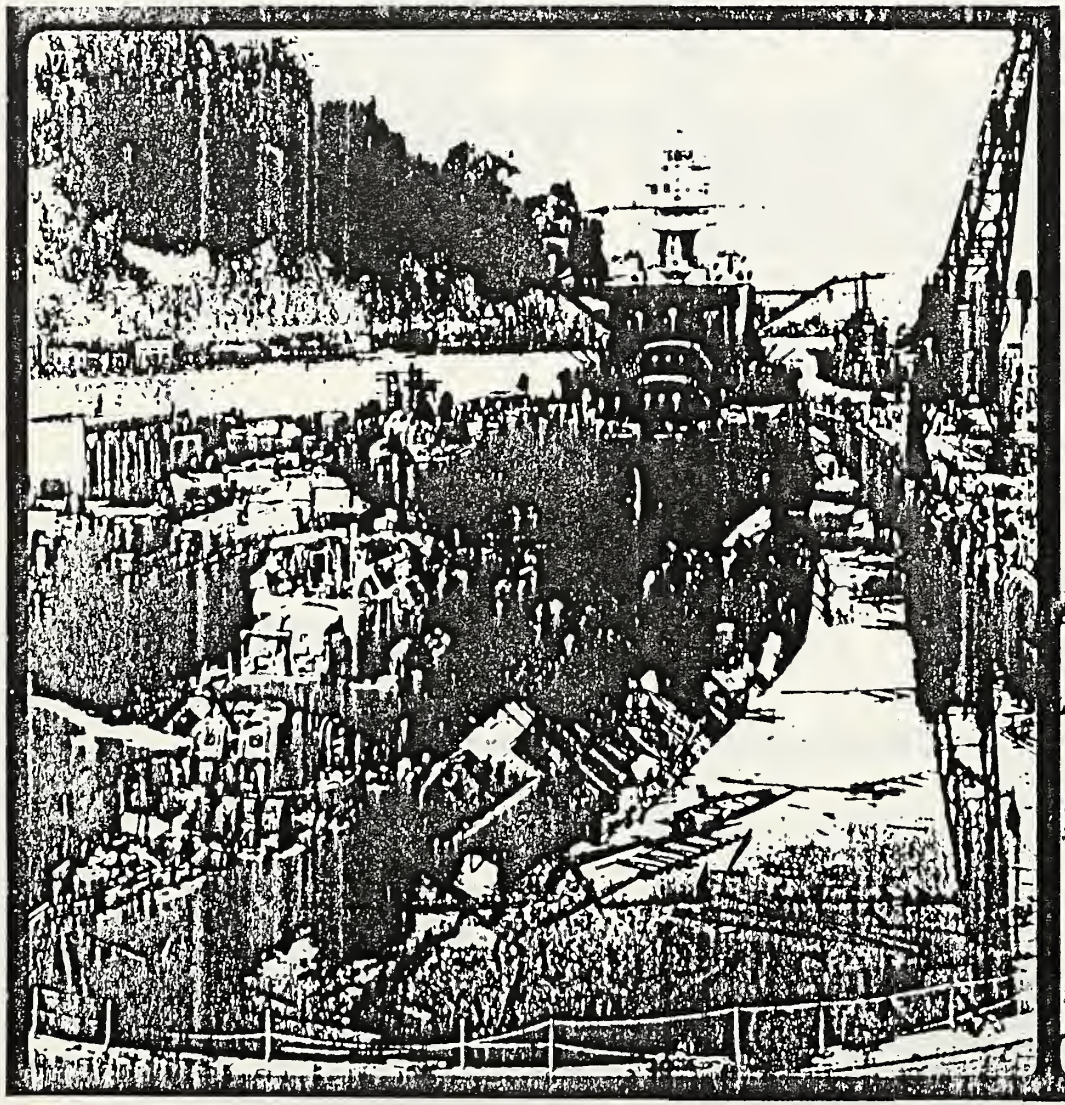


Transports
Points
Launches
Integral Power

WHY AIR DEFE..SE IS NEEDED....

air defense needed for survival

historical losses from tactical aircraft



Pec arbor in 1941

A highly effective air defense system is required to save the lives of soldiers and maintain the combat effectiveness of our ground and air forces.

The staggering losses that can be inflicted by tactical air power are shown by classic examples:

- Pearl Harbor
- Soviet Ground Forces in World War II
- Egyptian Forces in Mitla Pass, 1967
- Egyptian Aircraft in 6-Day War



Damage to Russian Motorized Unit ' 941

Hawk, a medium altitude SAM. The Project Group examining the replacement of NIKE Hercules recommended Patriot as the most suitable choice in August, 1978. This was followed by the initial signing by 4 European countries of the MOU in October.[209] Whereas the Patriot will be replacing both the Improved Hawk and the NIKE Hercules for U.S. forces, the NATO Project Group for a European replacement of Improved Hawk opted for the modernization of the existing system, instead of a new system.[210]

While these multi-lateral efforts have continued, the FRG, which has the largest requirement of the European nations for the system and whose Air Force has established Patriot as their highest priority acquisition program, has proceeded bilaterally with a series of initiatives with the U.S. Serving as a positive step toward the firm establishment of the NATO Patriot Acquisition Program, this bilateral effort has involved discussions with the OSD and the Department of the Army, leading toward a bilateral MOU. This MOU will allow the FRG to work directly with the relevant U.S. agencies:

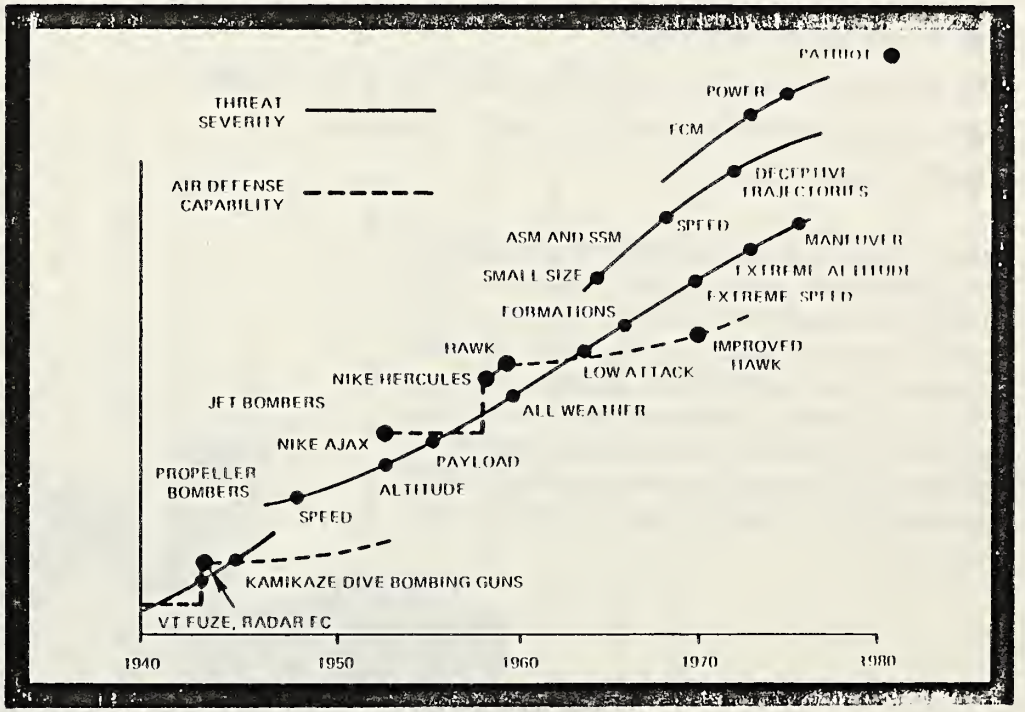
- in developing data to satisfy their national regulatory and statutory requirements, and;
- obtain the interface documentation allowing them to proceed with development of such nationally common military equipment as trucks, generators and other Government Furnished Equipment (GFE).[211]

the worldwide air threat consists of thousands of aircraft of increasing sophistication

The future air threat to our forces consists of the large numbers of high performance aircraft possessed by the Soviet Union, its satellites, and its client states, supported by the growing sophistication of Soviet technology in defense suppression techniques and tactics.

The Warsaw Pact nations maintain a tactical Air Force of 5255 aircraft. In addition, aircraft have been disseminated to countries such as China, United Arab Republic, North Korea, Cuba, Syria, Iraq, and Algeria. These nations have a combined inventory of an additional 5400 tactical aircraft.

The massive use by the Soviet Union of electronic countermeasures and chaff as aids to its tactical aircraft has been observed for many years in training exercises and confirmed tactically in the invasion of Czechoslovakia. There is no question that our own future air defenses must be prepared to cope with such techniques. If the established pattern is followed, the newer suppression techniques and tactics will eventually spread throughout the world during the PATRIOT life cycle.



4955 Warsaw Pact aircraft confront NATO's 2908 *

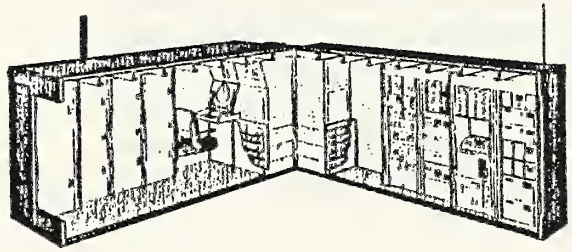
* Source: orce Magazine/December 1975

HOW PATRIOT DOES THE JOB....

the PATRIOT air defense system provides....

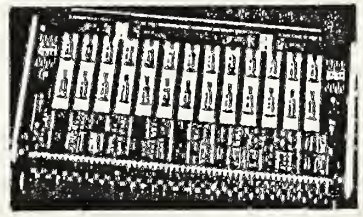
- Increased Firepower
- Effectiveness/Survivability in Hostile Environment
- Combat Readiness and Field Suitability
- Reduced Costs

PATRIOT has the firepower, multiple engagement capability and fast reaction to cope with the threat. The system is essentially immune to suppression tactics such as electronic countermeasures and antiradiation missiles, and can handle saturation attacks as well as low level "pop-up" and high-g maneuvering targets. The advanced technology used in designing PATRIOT inherently lends itself to a high order of combat readiness.



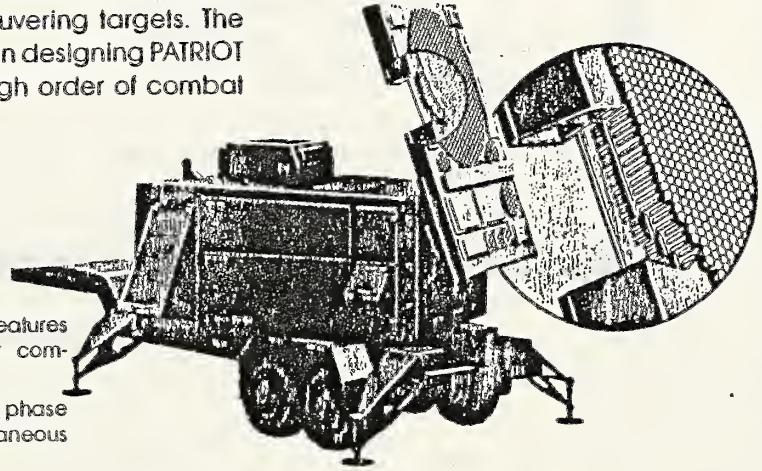
Engagement Control Station

Provides automatic control of radar and missile actions . . . features high-speed digital processing . . . provides man/machine interface.



Microelectronic Module

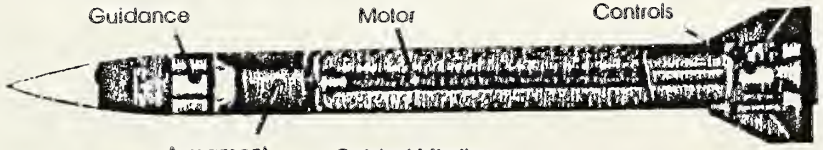
Featured throughout the system enabling component standardization and yielding high reliability. Only 234 different repair parts are required in the logistics chain to support all system light electronics.



Radar Set

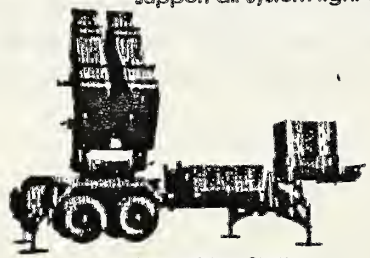
Provides all radar functions . . . features electronic beam scanning under computer control.

Antenna consists of five thousand phase shifting elements allowing instantaneous positioning of beam in space.



Guided Missile

Provides high performance against entire threat spectrum . . . features a unique guidance system that defeats defense-suppression tactics.



Launching Station

Provides a trainable and stable missile launch platform . . . features an RF data link to permit remote locations . . . the reusable missile canister serves as both a shipping container and as a launch tube.

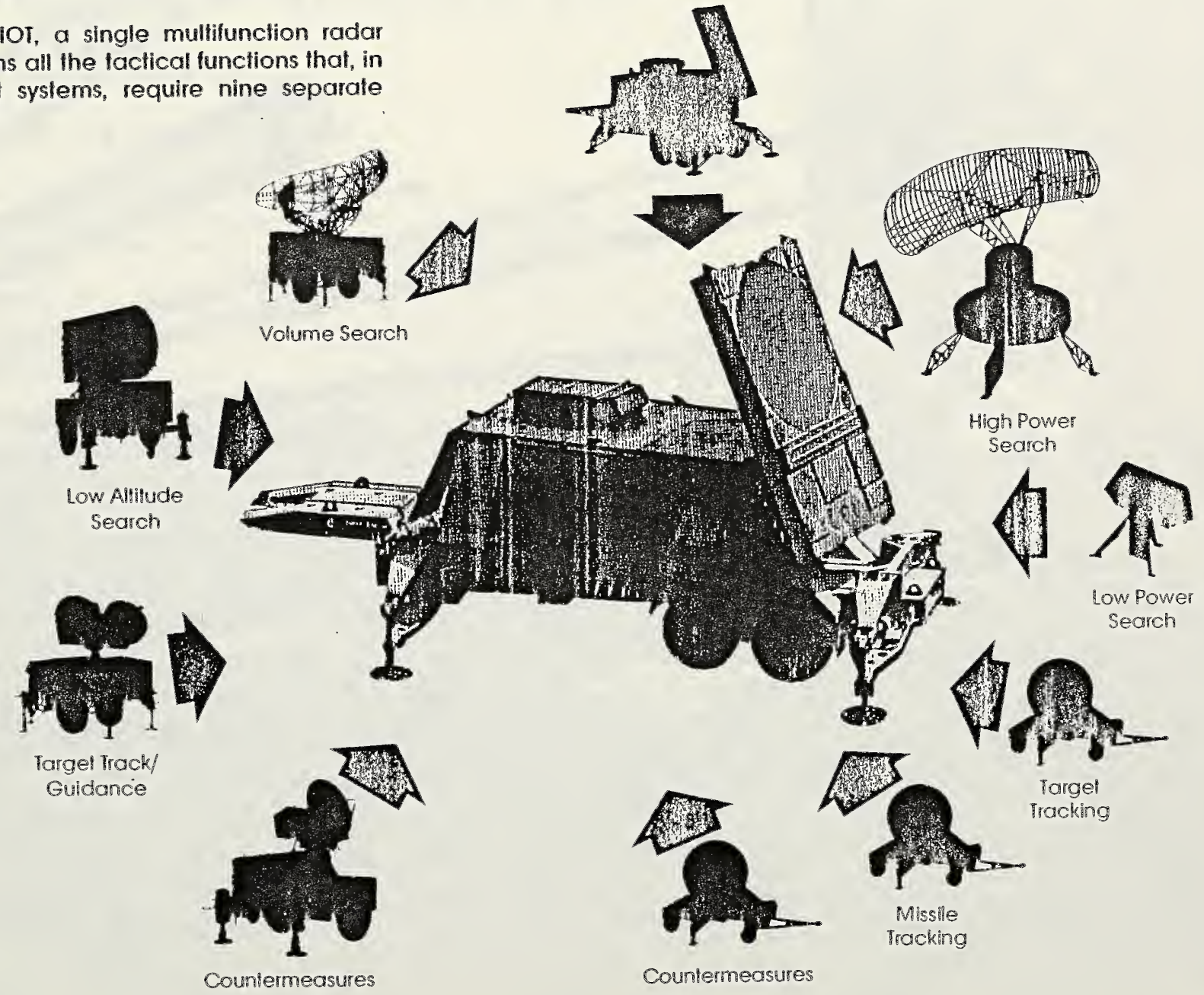
c. Gearing-up in the U.S.

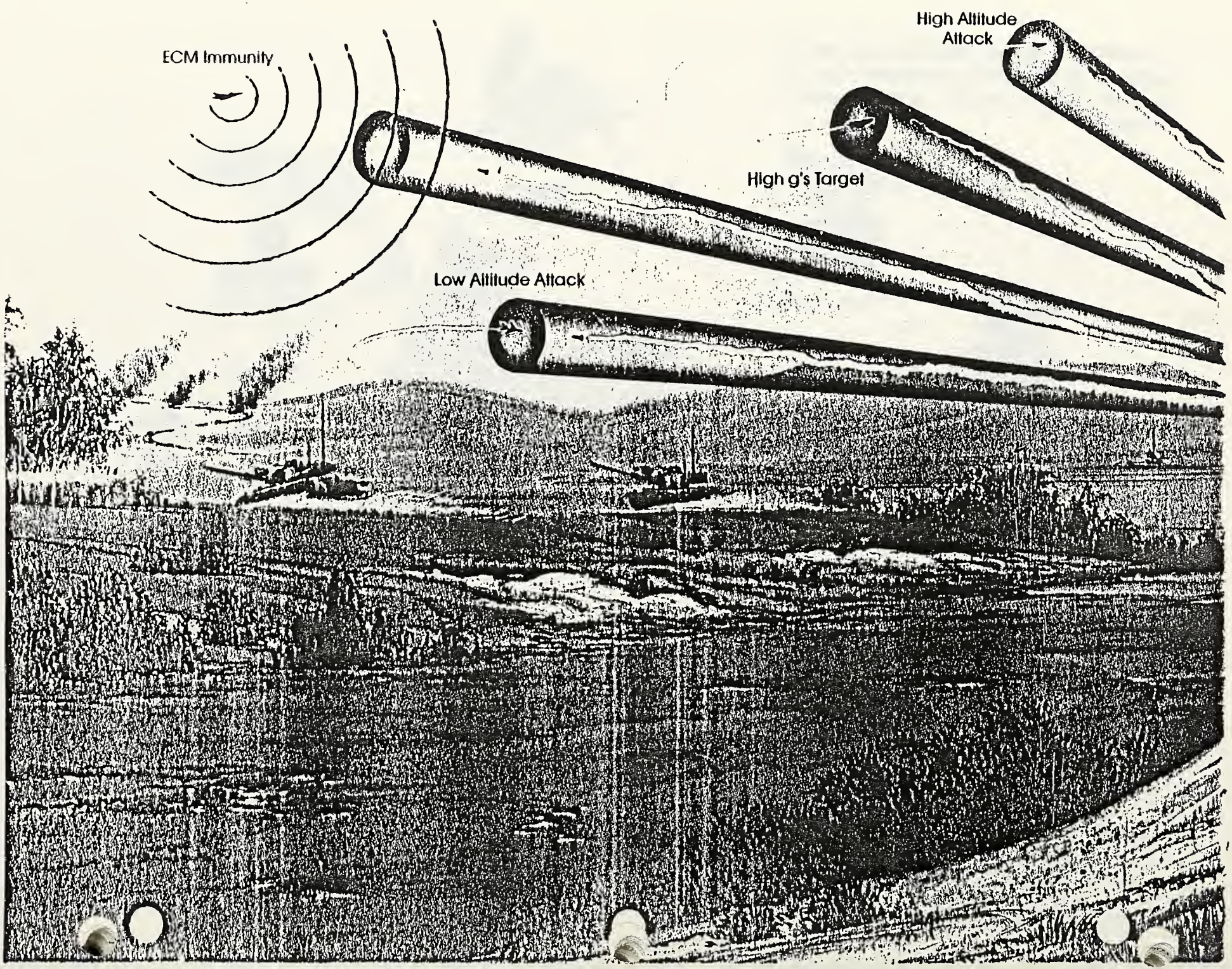
In the U.S., preparation for the technology transfer process involved in the European NATO project has also been moving forward. The Patriot Project Manager's Office has, in parallel with on-going studies by NAPATMO, developed a NATO RSI[212] Plan. The RSI Plan addresses and responds to the U.S. government's requirement for timely consideration of arrangements for joint development, and/or production, plus the cooperative support of weapons systems.

The Plan, which identifies the objectives of a viable RSI program for Patriot and examines various alternatives for maximum standardization and interoperability, was forwarded to the Department of the Army for final review and approval. In further support of RSI the Patriot project manager, Maj. Gen. Oliver D. Street III, has established an assistant project manager for international operations, A. Q. Oldacre, under whom 11 personnel have been working in a matrix relationship with the balance of project personnel.[213]

Authority for the Patriot project manager to be the release authority for certain initial background documentation has also been requested of the Department of the Army. The project manager subsequently received an approved Data Disclosure Authority Letter (DDAL) stipulating which documentation is releasable by the Patriot project manager and provides an expedited procedure to be used to forward data to NAPATMO.[214]

In PATRIOT, a single multifunction radar performs all the tactical functions that, in present systems, require nine separate radars.




ECM Immunity
High Altitude Attack
High g's Target
Low Altitude Attack

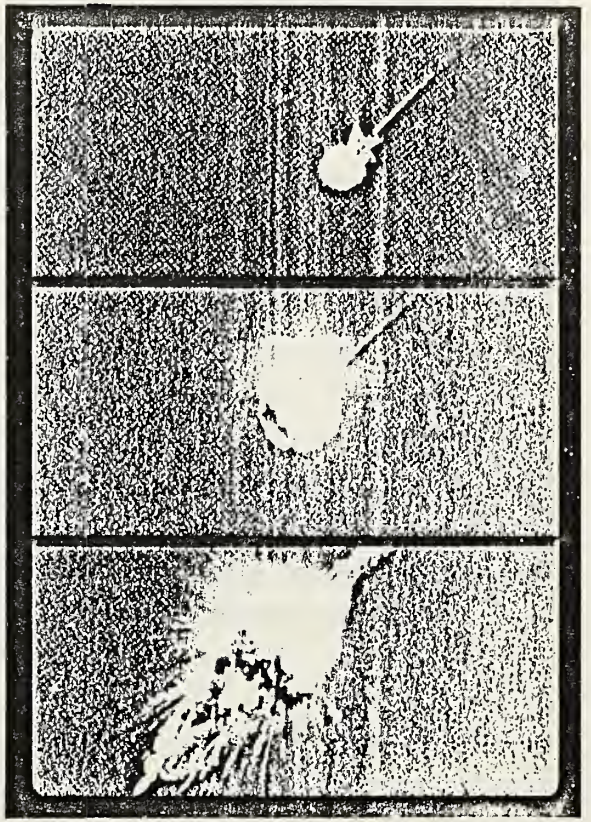
WHERE PATRIOT IS TODAY....

proof of principle

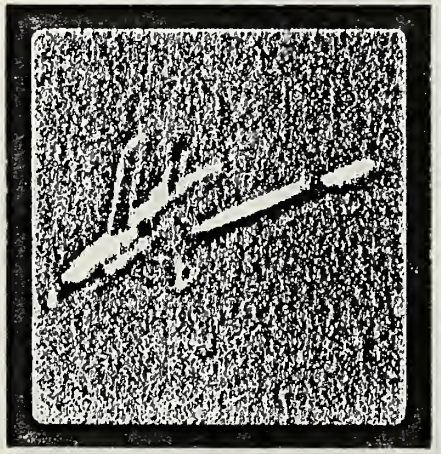
Department of Defense criteria for demonstration of the PATRIOT target-via-missile guidance concept required successful intercepts against four selected threats:

- single target
- target in formation
- maneuvering target
- low altitude target in clutter

These criteria were met in the first six firings. Out of eleven total guidance flights, ten were unqualified successes, with three direct hits.



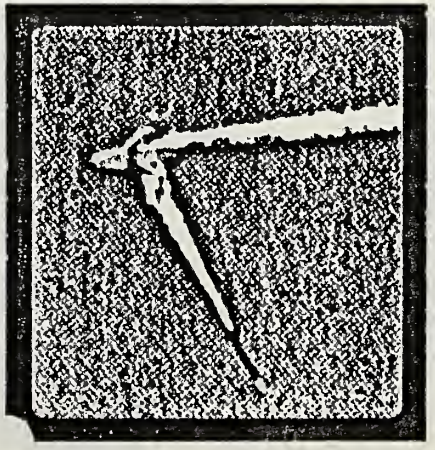
Single Target



Target In Formation



Maneuvering Target



Low Altitude In Clutter



WHERE PATRIOT IS TODAY....

program accomplishments

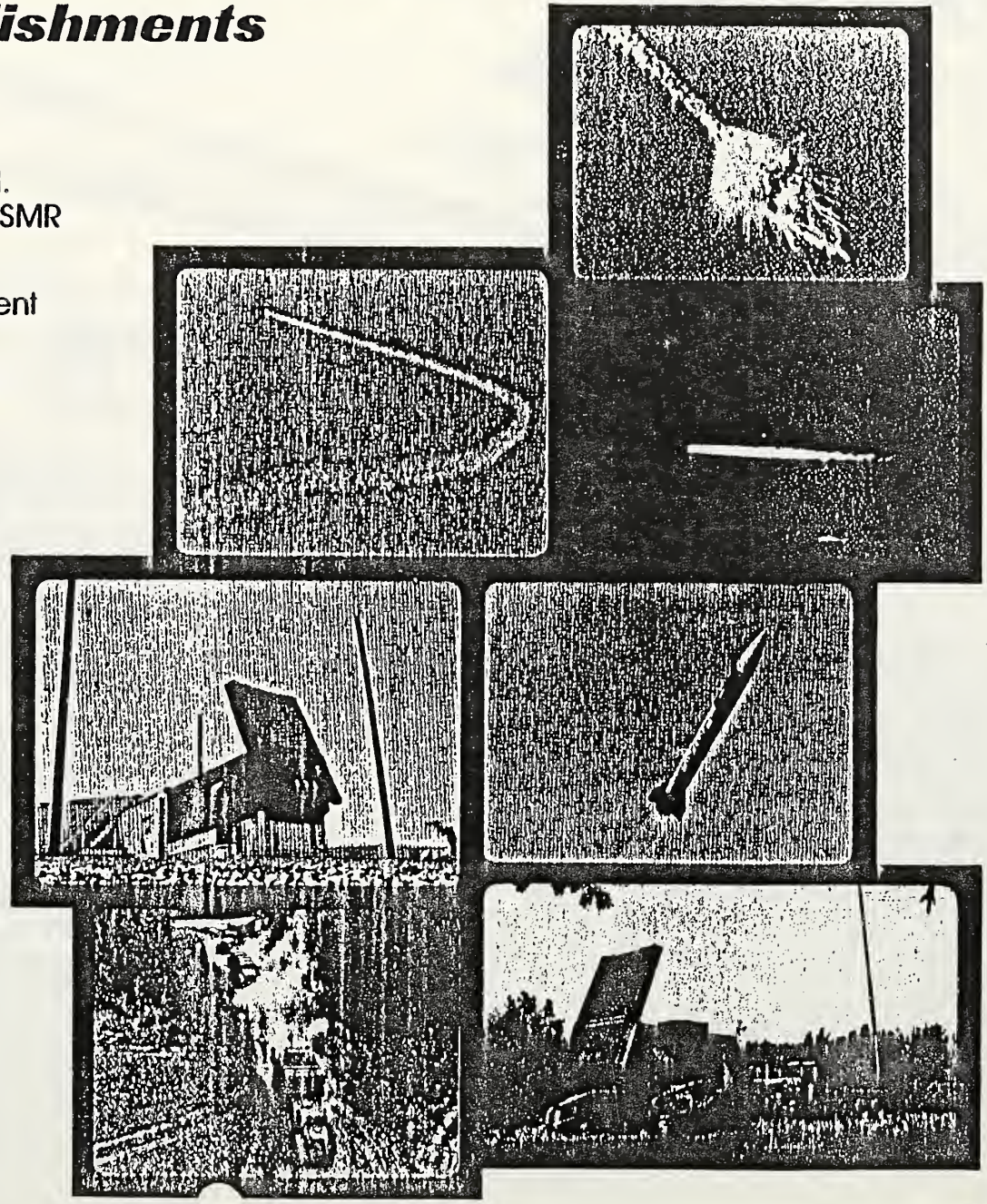
Proof of Principle Completed

Tactical Prototype Firing Platoon No. 1. Integrated and in operation at WSMR

ECCM Functions Demonstrated

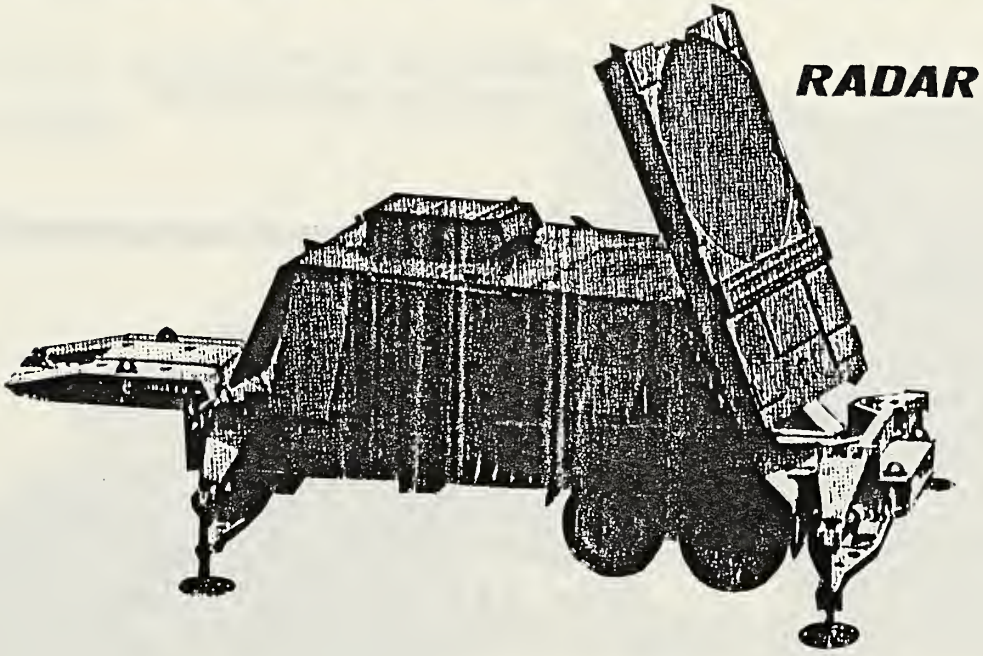
First Mobile Firing Platoon Emplacement Demonstrated

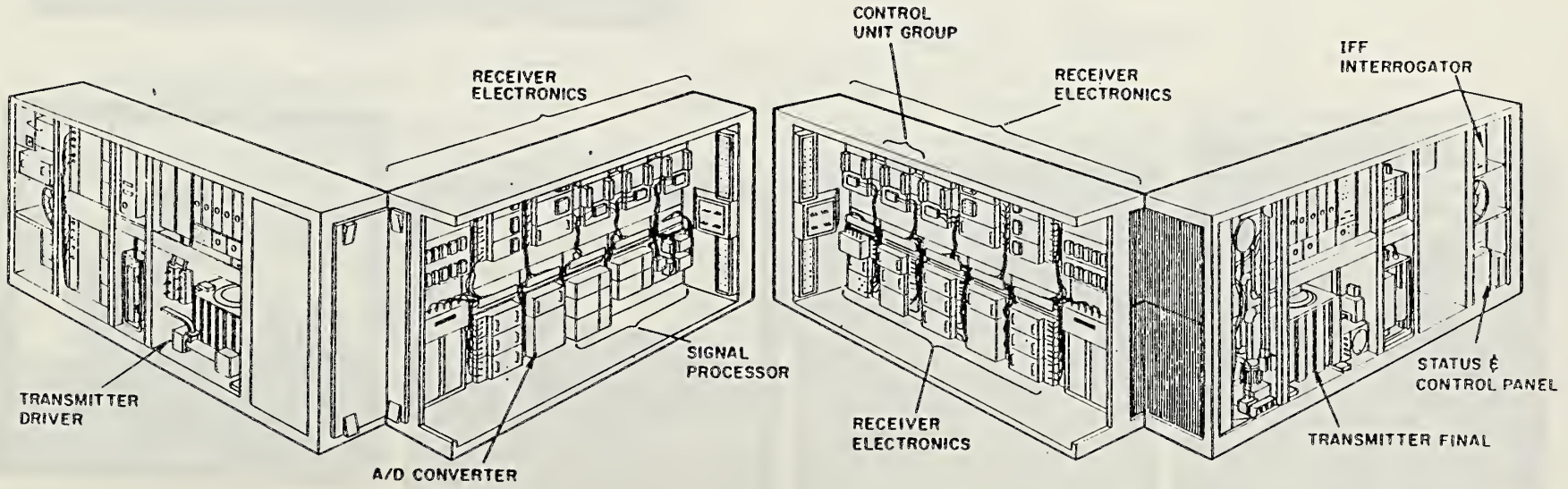
Tactical Systems Firing Tests with ECM Fourth Quarter 1976



WHERE PATRIOT IS TODAY....

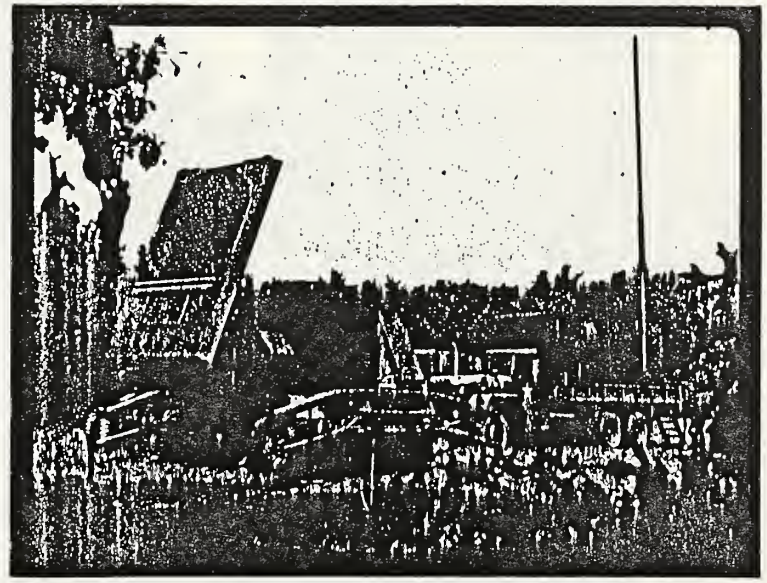
RADAR SET, AN/MPQ-53



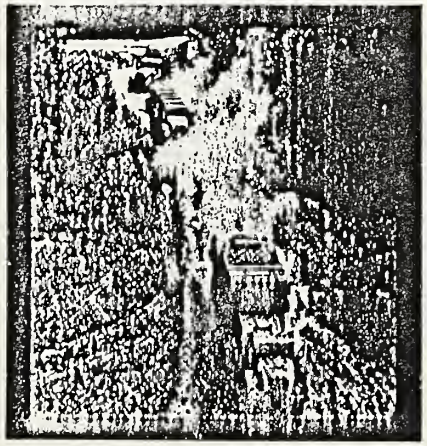


first mobile firing platoon emplacement demonstrated

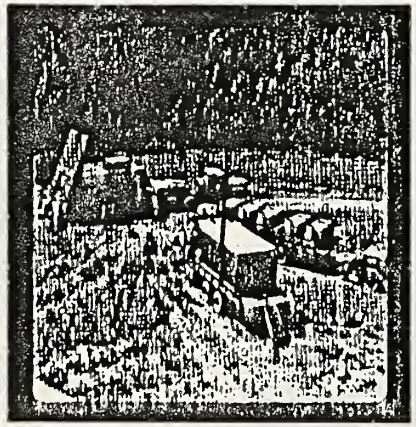
The first mobile, tactical PATRIOT firing platoon equipment has been assembled. Emplacement and march order demonstrations have shown the capability of PATRIOT to operate under field army conditions. Firing platoon No. 2 is now undergoing system integration testing in preparation for shipment to White Sands Missile Range and subsequent firing tests.



fire control section in road march



fire control section emplaced



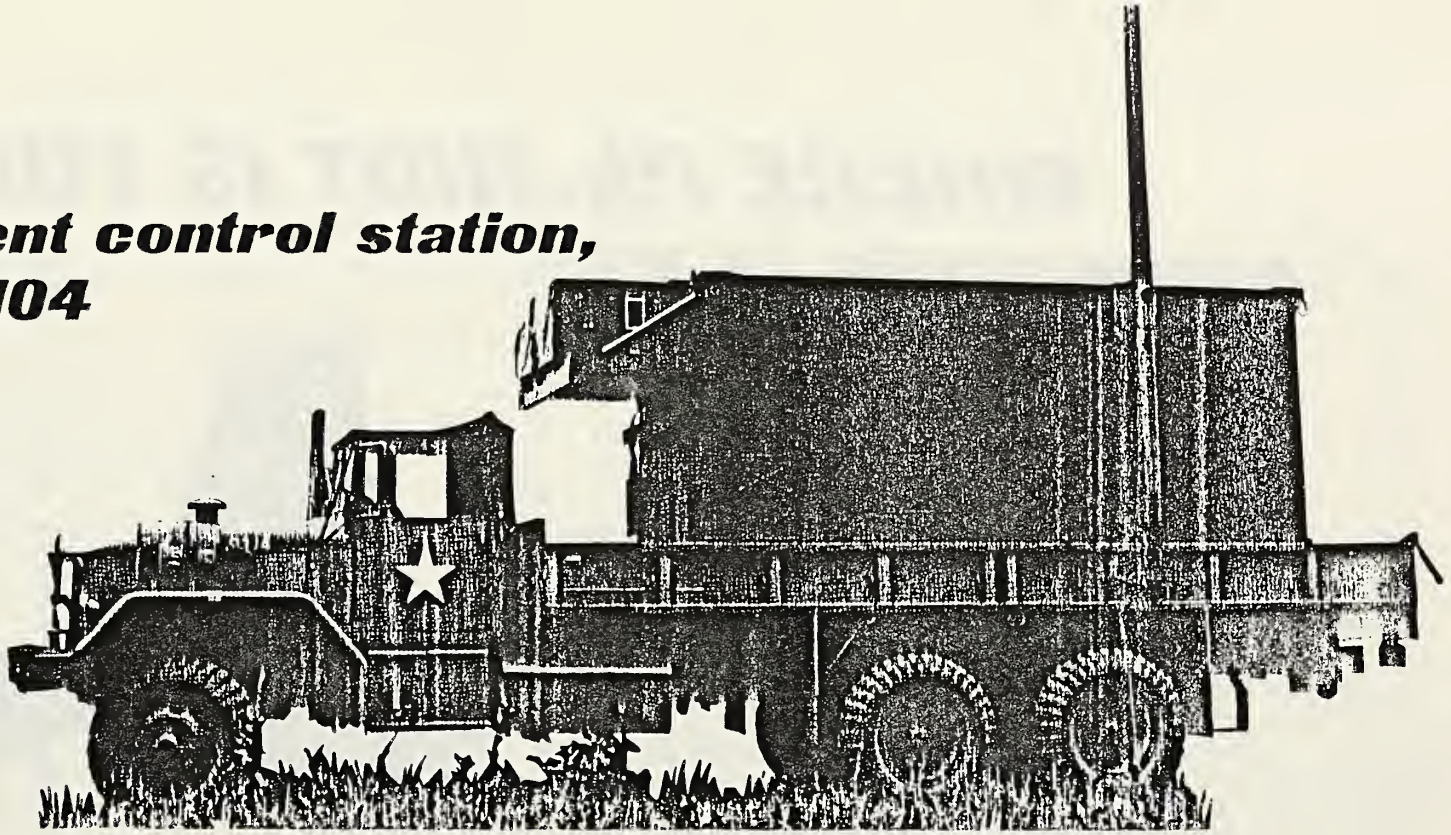
launching section in road march

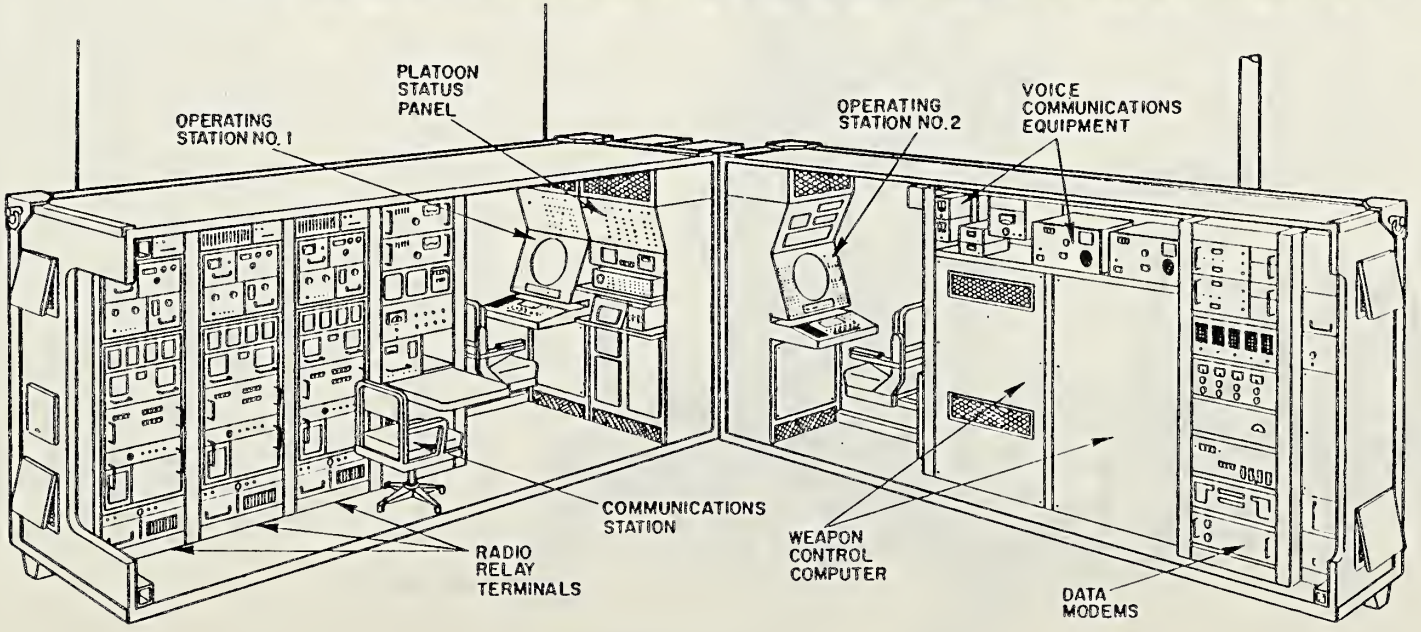


launching section emplaced



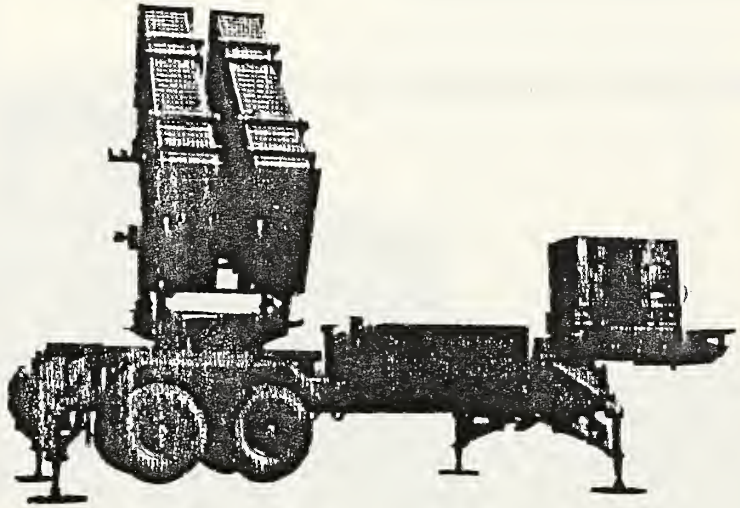
engagement control station, AN/MSQ-104

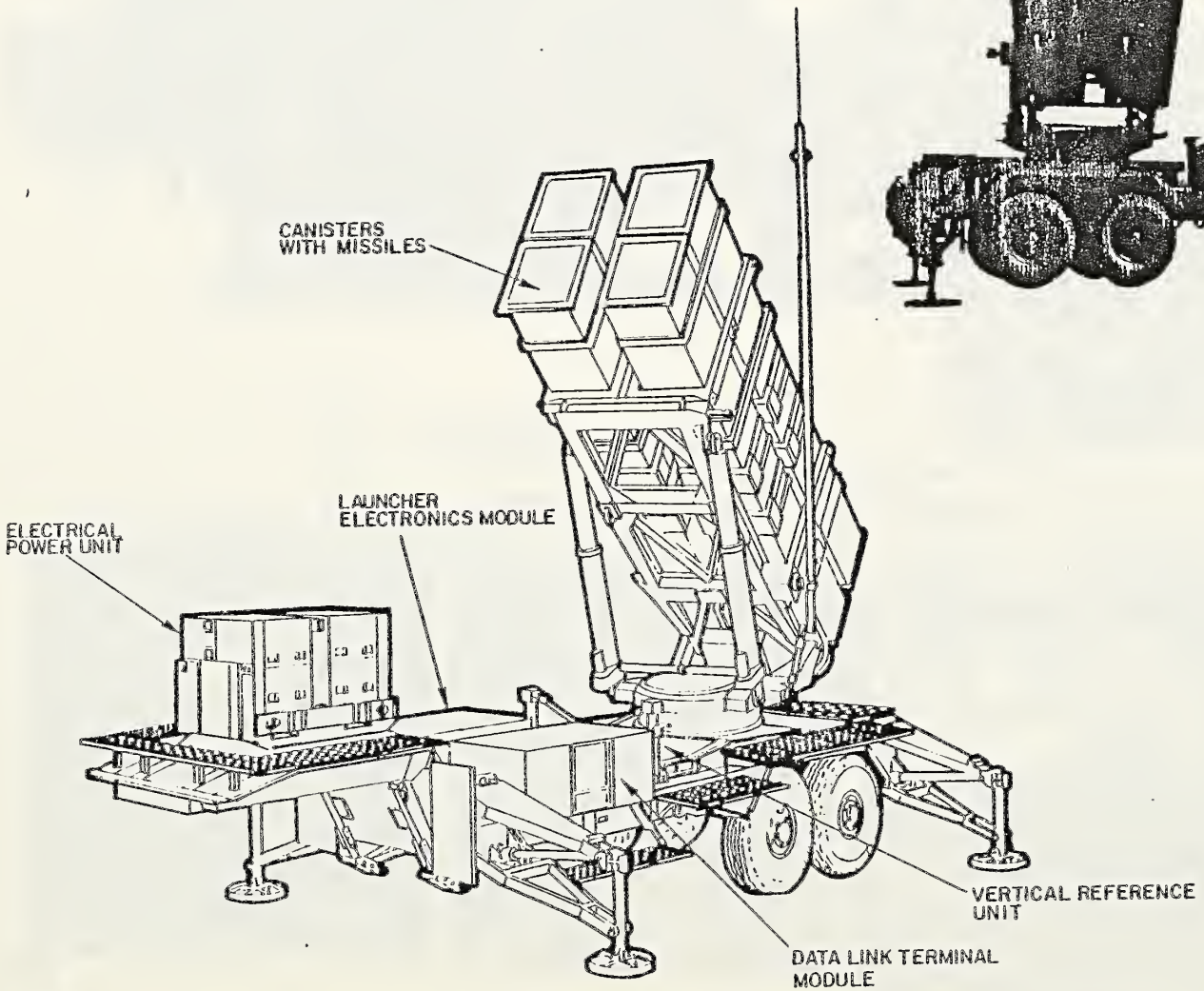




WHERE PATRIOT IS TODAY....

LAUNCHING STATION, XM-901





For its part, the Department of the Army has drafted, in conjunction with project representatives and contractor inputs, a Policy Guidelines Document for Technology Transfer, and has been coordinating its finalization with the relevant Army, OSD, and State Department agencies. This policy document will be the basis for agreement by the State Department's Office of Munitions Control vis-a-vis the extent of technology to be transferred during the cooperative program.[215]

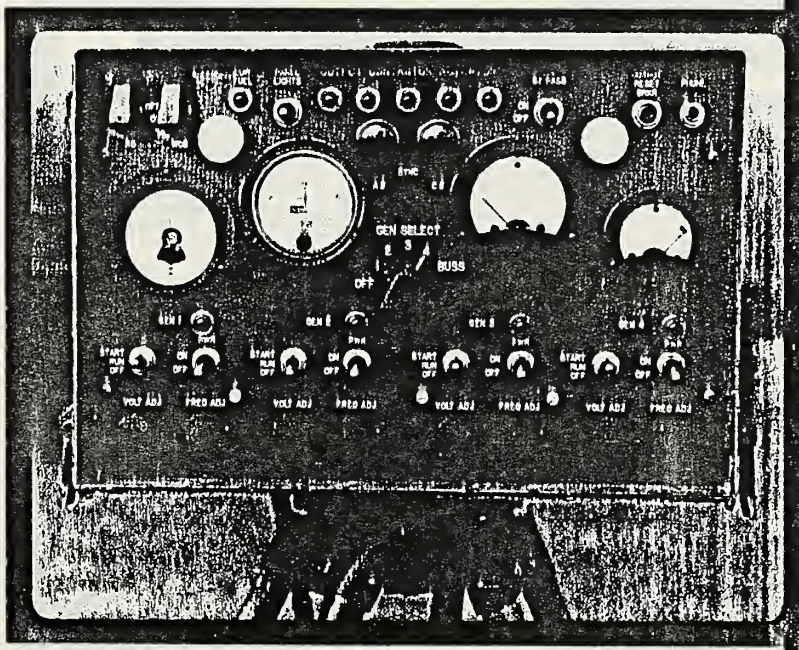
The Department of the Army has also, in light of the program's expense for those NATO nations acquiring it and the possibility of direct purchase, initiated an effort to begin identifying potential offsets that might be used in the final bargaining process.[216]

A group from NAPATMO visited the U.S. in March, 1979, for a tour and briefings of Patriot hardware and production facilities. The group visited the project office at Huntsville for technical and management briefings, moved on to the White Sands Missile Range, New Mexico, to see ground equipment and missile tests, and then, traveled to Massachusetts for a look at Raytheon's production site.[217]

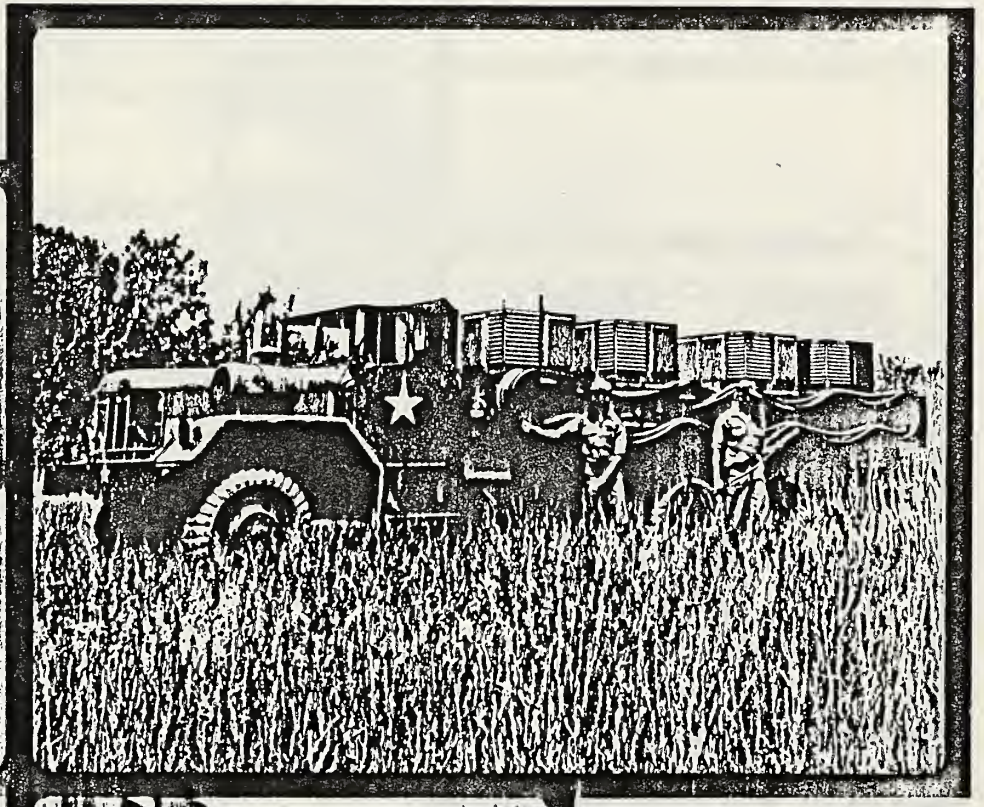
At the August, 1979, quarterly meeting of the NATO program Steering Committee, the U.S. was formally requested, and provided the necessary funding, to develop Technical Information Packages for NAPATMO. This is to help NAPATMO conduct its European Industrial Survey to determine the interests and

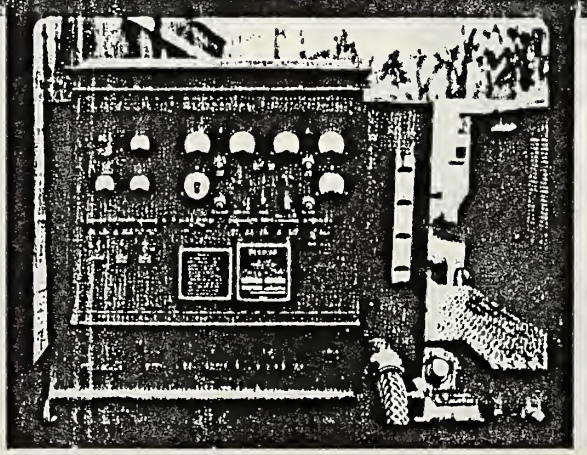
WHERE PATRIOT IS TODAY....

ELECTRIC POWER PLANT, AN/MJQ-20



Remote Control Unit

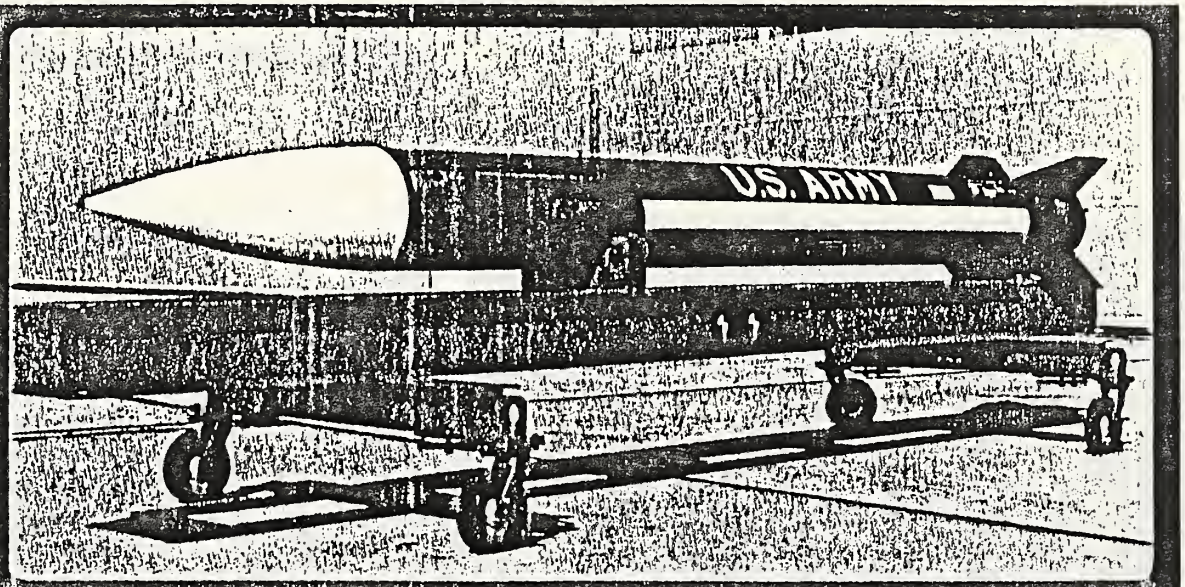




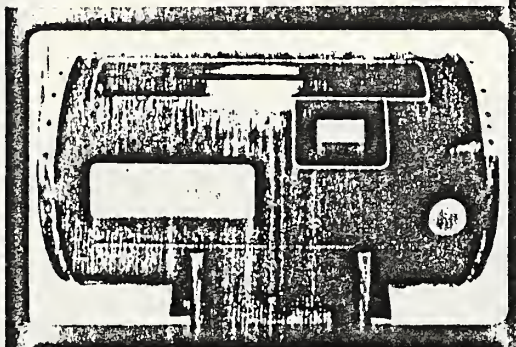
60 K" Generator

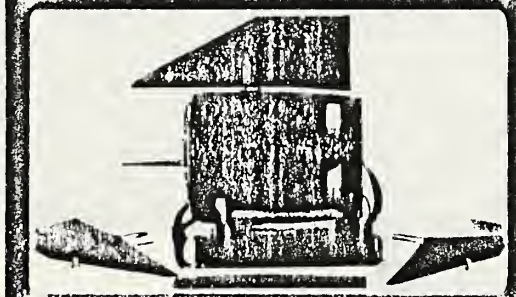
guided missile, intercept-aerial

XMIM-104



Warhead

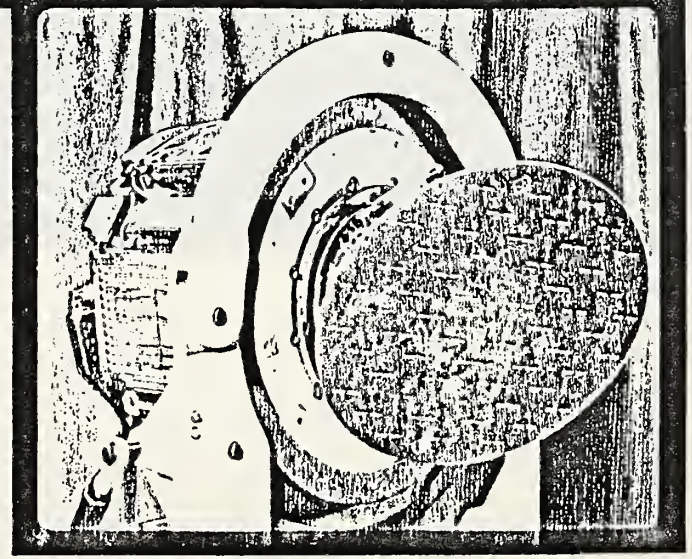




Control Actuator



Motor

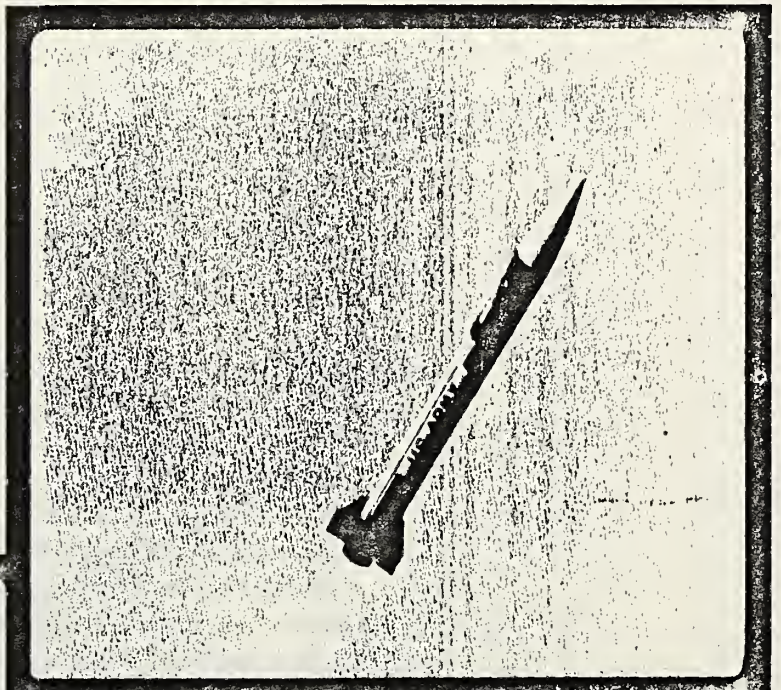


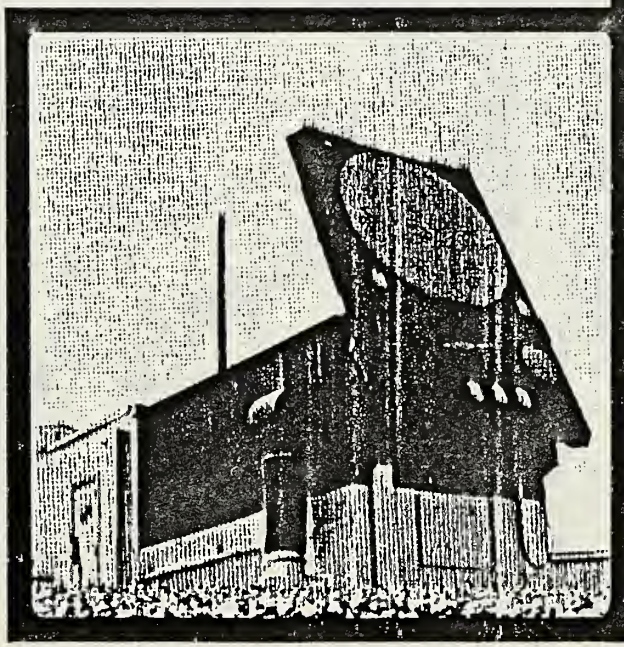
Airborne Guidance Section

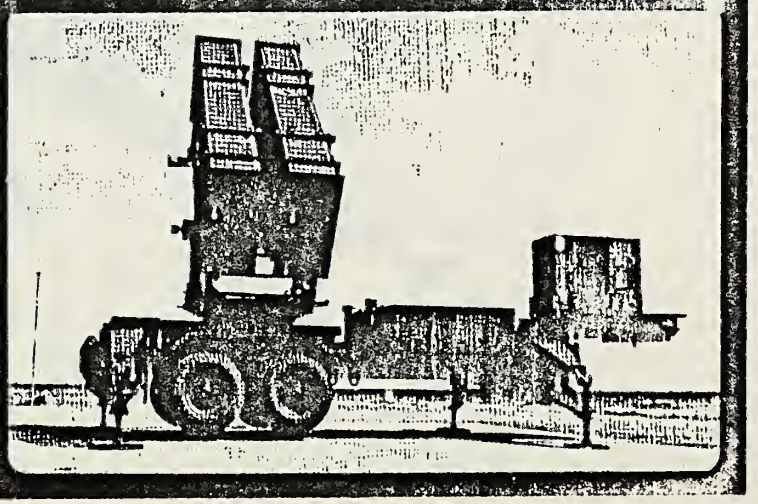
the next step

firing tests in an ECM enviroment

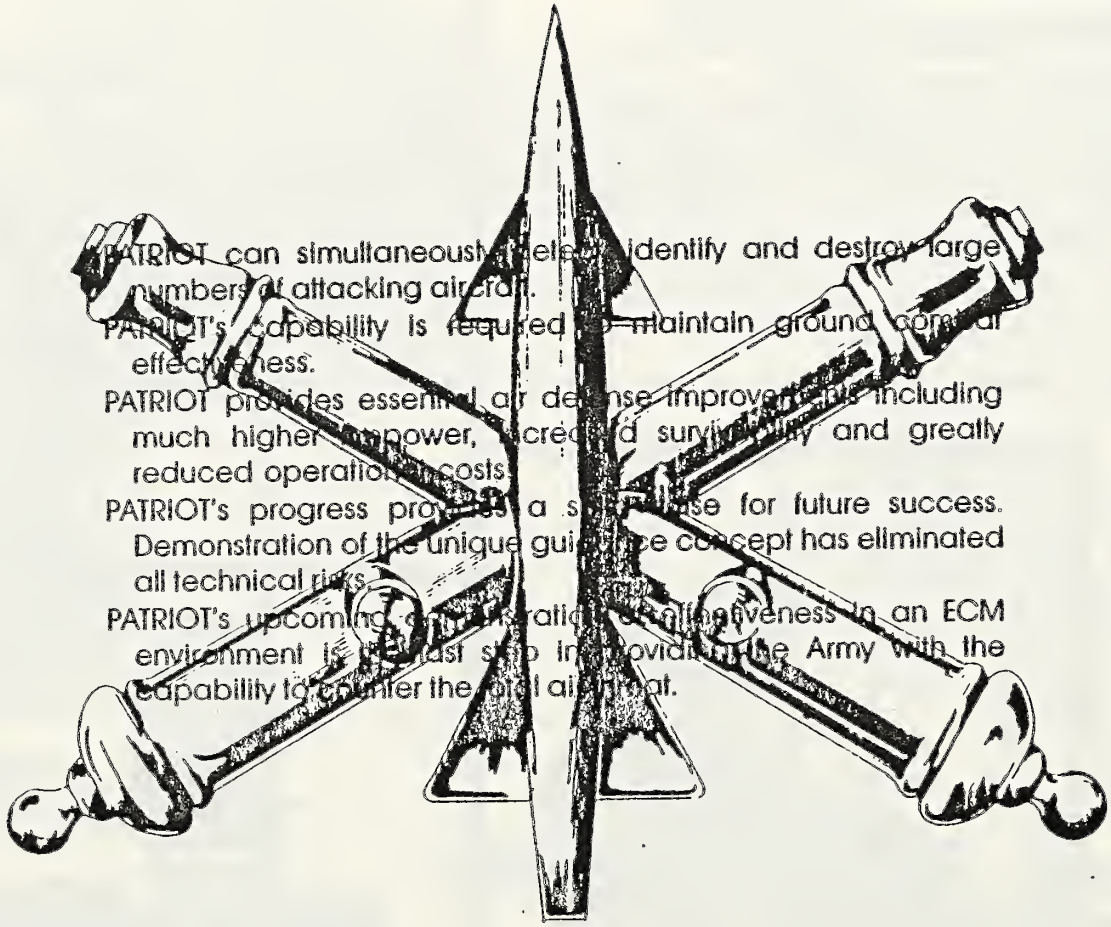
- stand off jammers
- self screening barrage jammers
- self screening formation barrage
- blinking jammers
- chaff
- multiple simultaneous engagements







summary



- PATRIOT can simultaneously detect, identify and destroy large numbers of attacking aircraft.
- PATRIOT's capability is required to maintain ground combat effectiveness.
- PATRIOT provides essential air defense improvements including much higher firepower, increased survivability and greatly reduced operational costs.
- PATRIOT's progress provides a solid promise for future success. Demonstration of the unique guidance concept has eliminated all technical risks.
- PATRIOT's upcoming demonstration of effectiveness in an ECM environment is the last step in providing the Army with the capability to counter the threat aircraft.

capabilities of European industry in a potential co-production option, plus to obtain planning cost estimates.[218]

Necessary contractual arrangements with Raytheon were made by the project office for these Technical Information Packages. The packages were to be screened by the project office and forwarded through the necessary channels for release. A series of visits by a U.S. government/contractor team of Patriot technical and program experts, to be completed by April 1980, was to take place for the purpose of providing technical assistance to NAPATMO and the European industries in understanding the Technical Information Packages.[219]

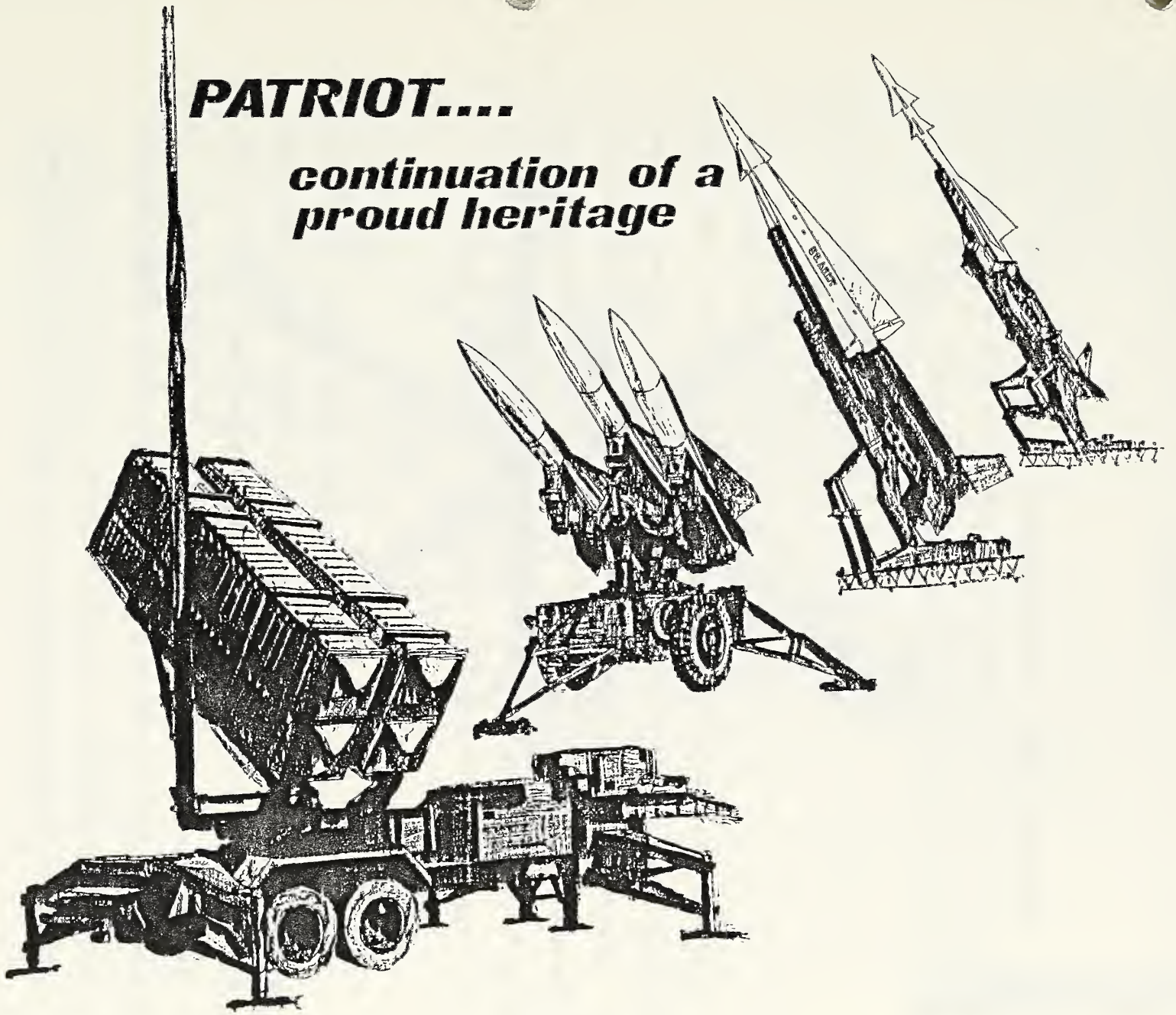
In spite of the extensive early coordination and planning described in the previous pages the usual centrifugal forces overcame the program. As of early 1986 the FRG and the Netherlands were the only two allies to have procured the Patriot, each under their own bi-lateral work distribution arrangements. The one with the FRG is described in chapter 9 as it relates to the Roland-Patriot SAM package, whereas the Dutch agreement involved the more conventional off-setting subcontracts.

d. Patriot - Lessons Learned

(1) As the FRG continues to balance its collaborative R&D and production ties among its 3 major allies—the U.S., France, and the UK—the U.S.-FRG axis still maintains considerable importance for promoting NATO RSI. Though

PATRIOT....

continuation of a proud heritage



PRINTED IN U.S.A.

having suffered such reverses in joint development with the U.S. (Mode #5) as MBT-70, AVS, and PHM, and having been impacted by moves toward increased independence by the FRG along with calls for greater reciprocity (i.e., the two-way street) the relationship has shown its on-going vitality through such recent programs as Roland, AWACS, RAM, AIM-9L, and now Patriot.

(2) Also of import are the participation of two other nations—France and Greece. France's initial interest in joining a recent major NATO program centered on a U.S. system shows once again its flexibility with regards to collaborating with the U.S. (even though the limitations imposed by Gaullist orthodoxy have also been recently shown by France with regards to the NATO AWACS project). As for Greece, being like France in its a la carte, or partially in—partially out status, this program also represented a positive step toward dealing with need to continue to expand the base of participants of collaborative programs. The more recent inclusion of small northern members—Denmark and Norway during the 70's needs to be followed by that of the developing southern members—Greece, Turkey, Portugal and now Spain. The degree to which this expansion is successful in the future will have an impact on Alliance solidarity. This issue is of such weight that it should be promoted by the more developed members to the point of involving some explicit subsidization.

(3) Being in its early stages, the Patriot program offers little in the way of salient "lessons learned." However, in line with the nature of all

the project histories contained in this paper, that of being non-comprehensive in its treatment, at least the material here outlines some of the steps involved in the process of setting up for a possible license production effort.

(4) Despite the lack of success ultimately in putting together a multi-lateral European second sourcing program for the Patriot, other bi-lateral arrangements involving work-sharing have been arrived at with the two allies having elected to procure the system as of 1986.

3. Copperhead

A third project taking shape along the lines of Mode #2 is centered on the Copperhead laser-homing 155-mm artillery projectile capable of hitting targets with indirect fire. An international industrial consortium named PGM Systems was formed in Nuremberg, FRG, in January, 1980 to plan co-production of the system, plus follow-on systems for European procurement. Copperhead is currently in production for the US Army, at Martin Marietta's Orlando Division in Florida. The U.S. Army has stated a requirement for up to 133,000 Copperhead rounds. Full scale production was authorized by the DoD in November, 1979.[220]

PGM Systems was set up, following marketing and consortium feasibility studies carried out by Martin Marietta, Diehl and British Aerospace in 1978-79, by Martin Marietta and Diehl. Its aim was to conduct detailed organization and capitalization studies with other participating firms from European customer

countries in order to establish a multinational European manufacturing corporation by January 1981. If this timescale is kept to, the first European-produced Copperheads could be delivered in 1983. Selenia and SNIA (Italy), the GSG consortium lead by Fabrique Nationale (Belgium), Marconi Space and Defense Systems (UK), Hollandse Signaal (Netherlands) elected to join up almost immediately, and negotiations were in progress concerning the industrial participation of Greece as of February.[221]

Projected European procurement is for at least 40,000 Copperhead rounds to be delivered between 1983 and 1990. The initial feasibility studies showed that, like the other projects in this Mode, potential Copperhead requirements from even the larger European countries were insufficient to support affordable single-country production but, if combined, would be enough to sustain a single multinational production source without having to build into the equation further sales outside NATO. First orders were expected to be placed in 1981 by Italy, the UK and Greece, followed by Belgium and the FRG in 1982. No firm procurement decisions, however, had yet been taken by these governments. France, Norway, the Netherlands, Canada and Denmark were also known to be studying Copperhead to assess its utility in the national concepts for operations. In addition, the work-sharing structure of the PGM Systems consortium is designed to be able to accommodate industrial participation by companies within additional purchasing countries if and when these countries make their decisions to buy Copperhead.[222] In terms of cost, PGM Systems recognizes that unit price per Copperhead round produced in Europe will have to be within 5-10

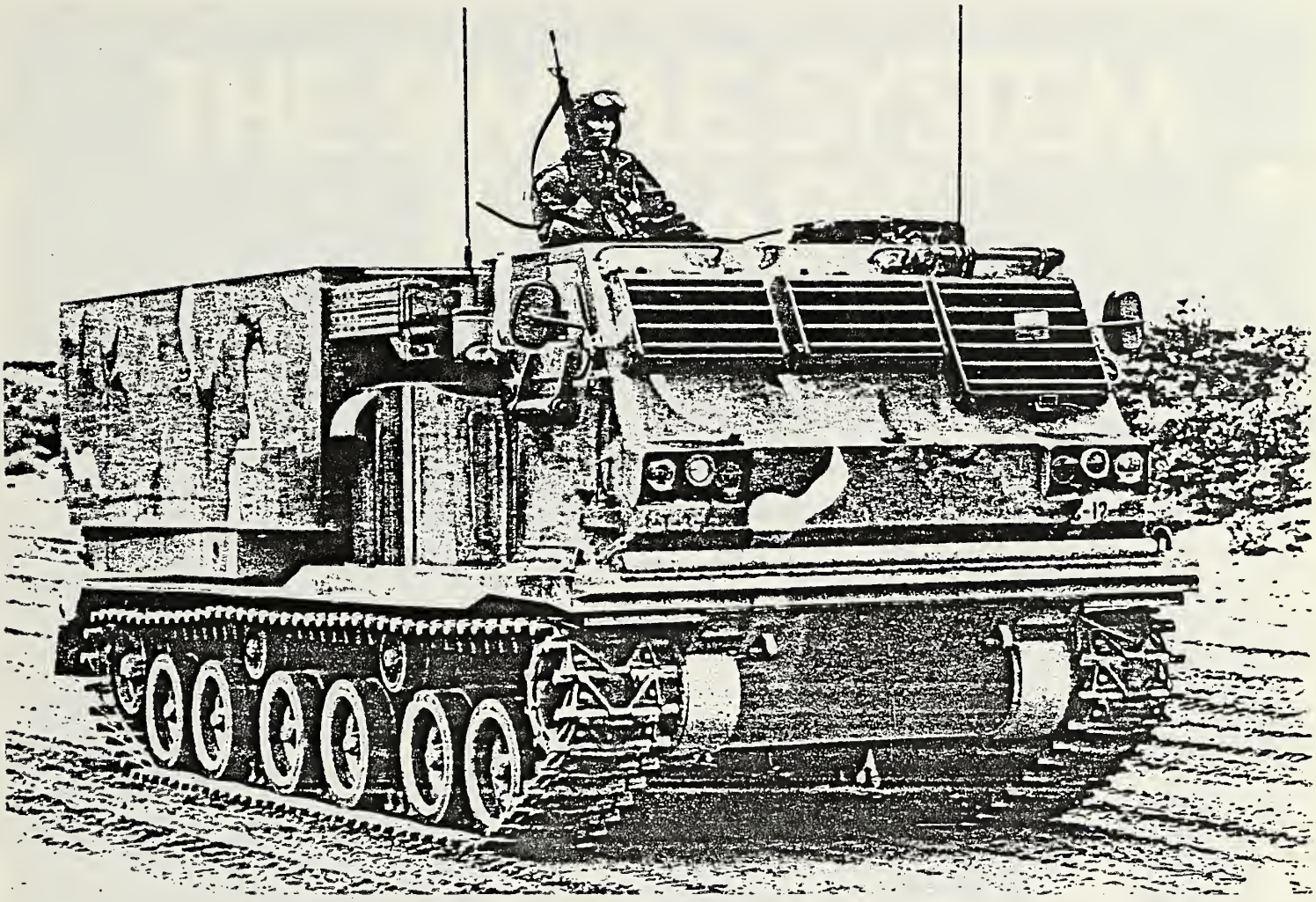
percent of the $12,000 per round anticipated for U.S. rate production if it is to be competitive.

4. Multi-launch Rocket System (MLRS)

a. The U.S. Army's GSRS Program

The U.S. Army Missile R&D Command (MIRADCOM) awarded development contracts in September 1977 to two of the five U.S. firms competing in the General Support Rocket System (GSRS) concept definition study phase - Boeing Aerospace and Vought (LTV). Boeing and Vought then entered a 29 month competitive design and validation phase.

The GSRS was designed to deliver a large volume of ordnance in a short period of time, against critical, time sensitive, area-type targets. This highly mobile system has two important missions. The primary one is the counter battery role, i.e., to be able to fire back at enemy artillery delivery systems, both tube and rocket so as to neutralize them. The second most important mission is the suppression of enemy air defense. There is a very high military need for such a system in all of the NATO nations, not just the U.S. The NATO allies are badly outgunned by the Warsaw Pact forces in conventional artillery and multiple rocket launchers. The GSRS was expected to make up for some of the firepower deficiency that currently exists. One volley of the GSRS was to be equal in fire power to that of 3 batallions of 8-inch howitzers.



LTV Technology Report: Tactical Missile Systems

THE FORCE MULTIPLIER

In less than 60 seconds, it can launch up to 12 rockets against targets ranging to more than 18 miles away. With unerring computer accuracy, they'll deliver thousands of grenades to devastate the target. And before the smoke clears, its 3-man crew can be on the move, ready to reload and launch another barrage from a new location. This is the Multiple Launch Rocket System—The Force Multiplier.

Designed by Vought Missiles and Advanced Programs, a division of LTV Aerospace and Defense Company, the MLRS gives the Army more mobile firepower than it's ever had before. Today, MLRS units are with divisions in Europe and Korea, as well as throughout the United States. And soon, MLRS will become operational with the armies of France, Germany, the United Kingdom and Italy.

Although it can launch a tidal wave of defensive fire, MLRS is so dependable and easy to operate that it's called the "Soldier's System." The fire control display communicates in plain language instead of code. Chassis and running gear are the same as those in the U.S. Army's Infantry Fighting Vehicle (IFV).

MLRS has been praised as a weapon system that "not only works as it should, it also came in on time and on budget." And it's just one example of how we're working to keep America and its allies out front in tactical missiles.

LTV Aerospace and Defense Company, Vought Missiles and Advanced Programs Division, P.O. Box 650003, Dallas, Texas 75265-0003.

LTV Aerospace and Defense

Vought Missiles and Advanced Programs Division

LTV IS LOOKING AHEAD

The U.S. Army plans call for procurement of 173 fire units of GSRS. The estimate for total life cycle costs of the U.S. GSRS project is about $5.1 billion, which includes $465 million for RDTE and $3.146 million for procurement.

The two competing contractors are each leading industrial teams. The Boeing team included:

- Thiokol for the rocket motor;
- Teledyne Systems Co. for the fire control equipment, and;
- Honeywell for the munitions dispersal subsystem.

The Vought team consisted of:

- Atlantic Research for the rocket motor;
- Bendix Corp. for the stabilized reference platform, and;
- Brunswick Corp. for launch tubes.

b. The GSRS Becomes the NATO MLRS Program

In late December 1977, the U.S., the FRG, and the UK signed a formal declaration of intent to cooperate in the design of a standard medium multi-launch rocket system and to develop a joint production program. The following month MIRADCOM notified Boeing and Vought that the GSRS program was being redirected to conform to the common requirements negotiated with the FRG and the UK. This basically involved redesign to accommodate the German AT-2 scatterable

THE SIMPLE SYSTEM IS READY.



The Boeing team is into the final stages of development and is preparing for MLRS production. Turn the page for details.

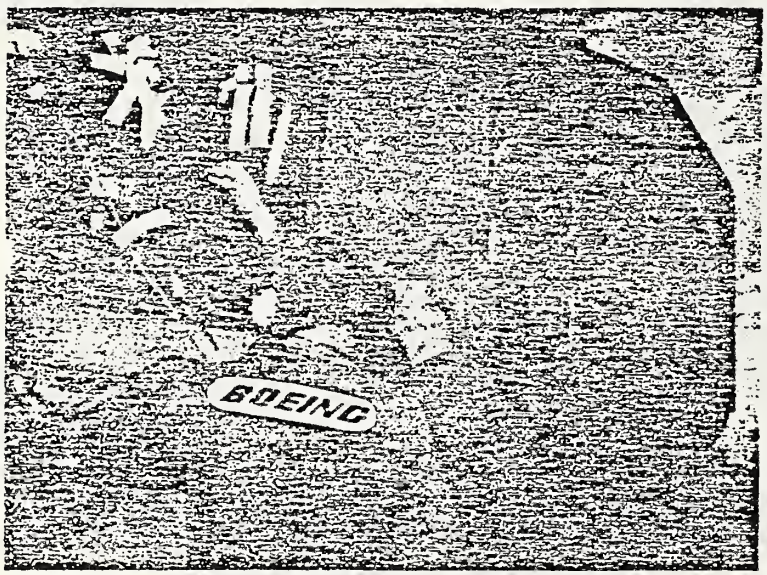
AND WE'RE RIGHT ON TARGET.

We're ready.

Developmental tests have proven our Multiple Launch Rocket System can meet all the artilleryman's requirements. Simply and effectively.

Nothing has been left to chance.

Dozens of tests have been conducted at a variety of locations. At White Sands Missile Range we fired the MLRS rockets. At Eglin Air Force Base we put the Simple System through environmental extremes. At Aberdeen Proving Ground we demonstrated the system's mobility.



Our Simple System hardware was built with production processes and methods. This is not a one-of-a-kind model.

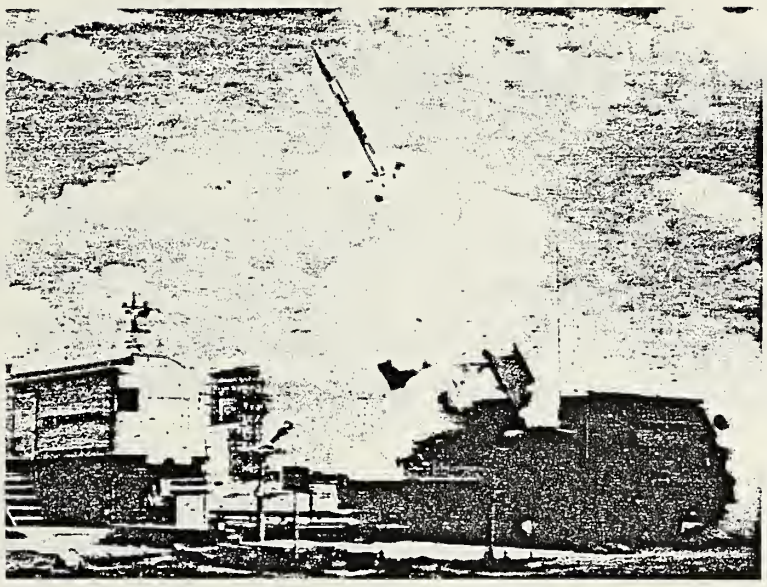
There have been no R&D shortcuts just to prove a point. Critical tooling processes are already proven.

And design for low-cost production has been the guideline for the Boeing MLRS team from the very beginning.

Every way you look at it, the Boeing MLRS is built for the soldier, and ready to go. In summary:

1. We've developed a rocket that has precise aerodynamics and repeatable performance.

2. We've designed a system that's readily standardized and interoperable with European equipment. And that's important in light of the agreement between the U.S. and West Germany,



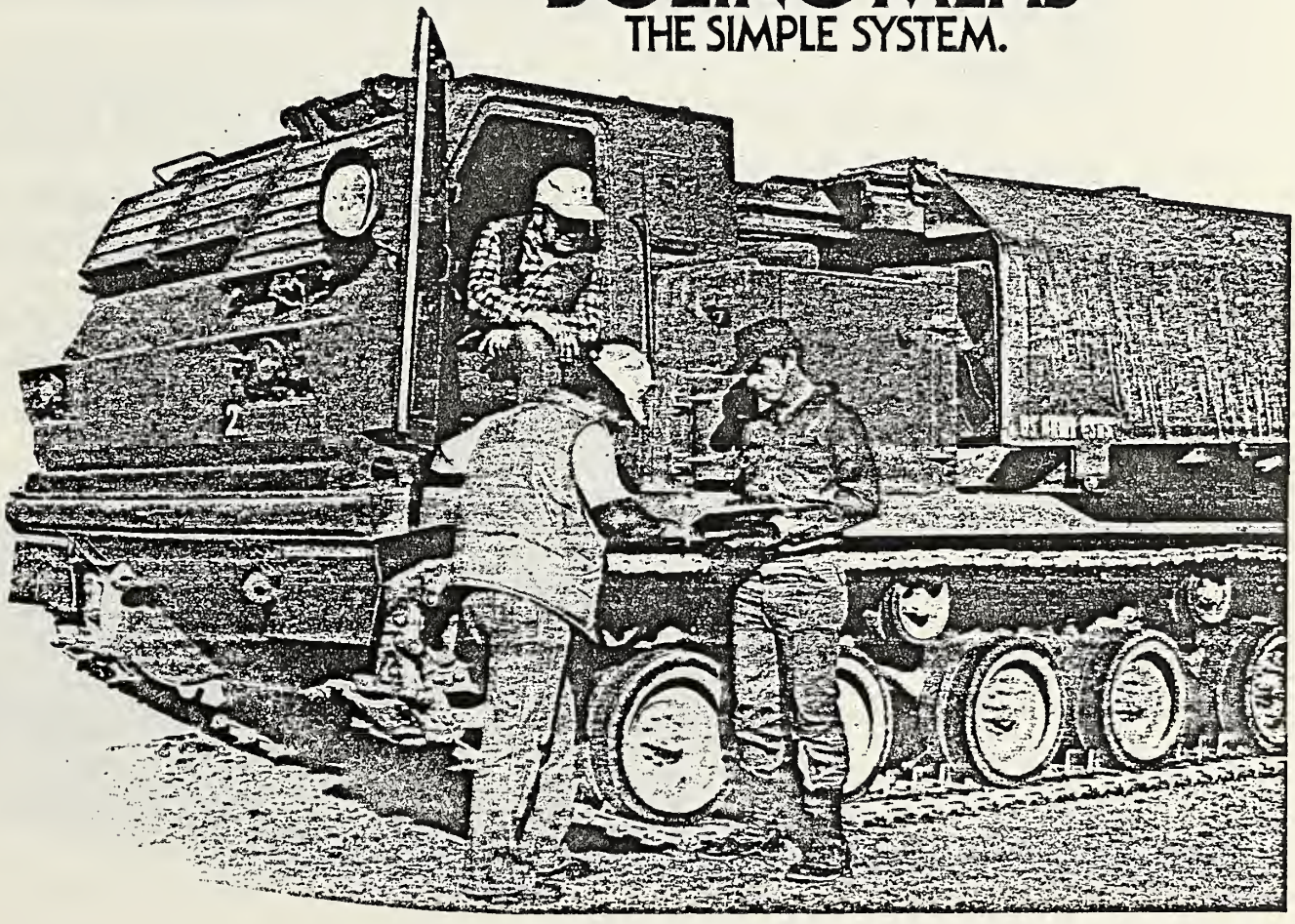
France and the United Kingdom on a cooperative MLRS program.

3. We've built in a shoot-and-scoot capability with quick reaction time.

4. We've engineered a system able to deliver cost-effectively a variety of munitions at a high rate of fire.

5. We've perfected the key manufacturing processes and tooling for high-volume production at a low cost per unit. And all this has been thoroughly checked out during manufacture of the current test hardware.

BOEING MLRS
THE SIMPLE SYSTEM.



WHO'S BEHIND THE SIMPLE SYSTEM?

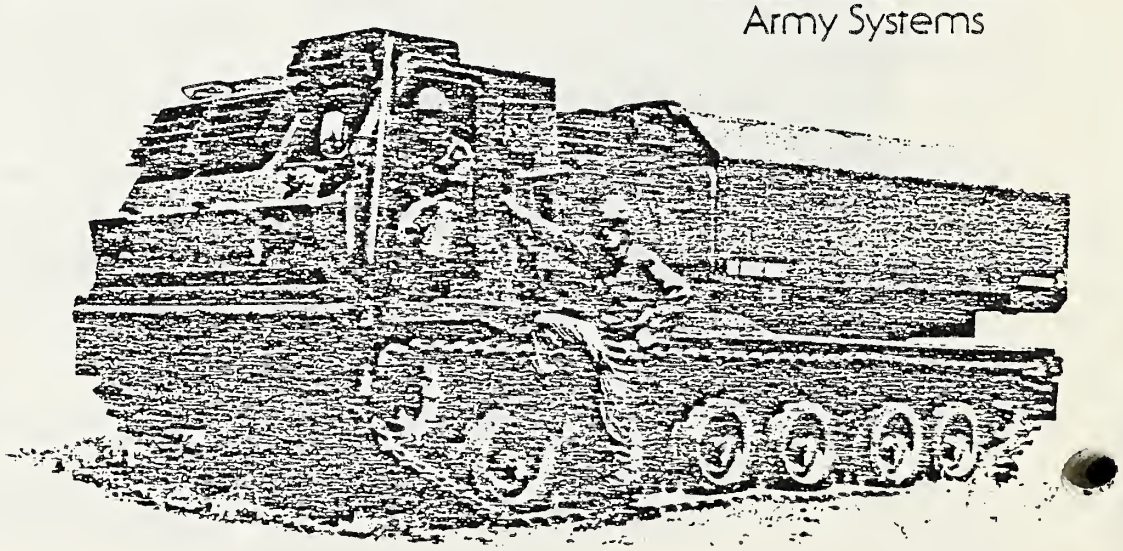
Boeing is a prime contractor on MLRS, working with three exceptionally experienced teammates. It's an excellent combination to design the total system, build the hardware, evaluate performance, set up production facilities, and meet delivery schedules on time.

Thiokol Corporation has developed the solid-propellant rocket motor. Thiokol's long experience has paid off in a new fiberglass case for the motor, and low-cost propellant. This in turn means reduced cost and lighter weight. All of the test motors have now been delivered to Boeing and the Army. On time.

Teledyne Systems designed and built the attitude reference system, fire control computer and associated software elements of the fire units. The system has performed as expected in the test program.

Honeywell's job has been to develop the munitions dispersal subsystem. This system provides for a large volume of munitions per rocket and good distribution on target. This innovative equipment is meeting all specifications, passing its flight and dispersal tests and operating as designed.

BOEING
Army Systems



anti-tank mine and a yet to be developed anti-tank mine with terminal homing provisions. The designation for the redirected GSRS was multi-launch rocket system, MLRS. Initially, the FRG and the UK were also to send one or two representatives to work at the project office at Huntsville. The primary goal of the program's redirection was development of a completely standard NATO system, but an option remained as well for interoperability only.

The U.S. Army had no requirement for the German AT-2 warheads, continuing to buy cannon artillery delivered scatterable anti-tank mines for which it has an existing delivery capability, and the development of which is 5-7 years ahead of the AT-2.

On June 11, 1979, in Paris, the national armament directors of the U.S., the FRG, France, and the UK signed an MOU that was expected, if things go as planned, to lead to a second production line in Europe for about 200 MLRS firing units and approximately 250,000 rockets.

The European country that had been most interested in the development of multi-launch artillery rocket systems had been the FRG. Their interest, which dates back into the 60's, stems from its potential use for area suppression in the anti-tank role.

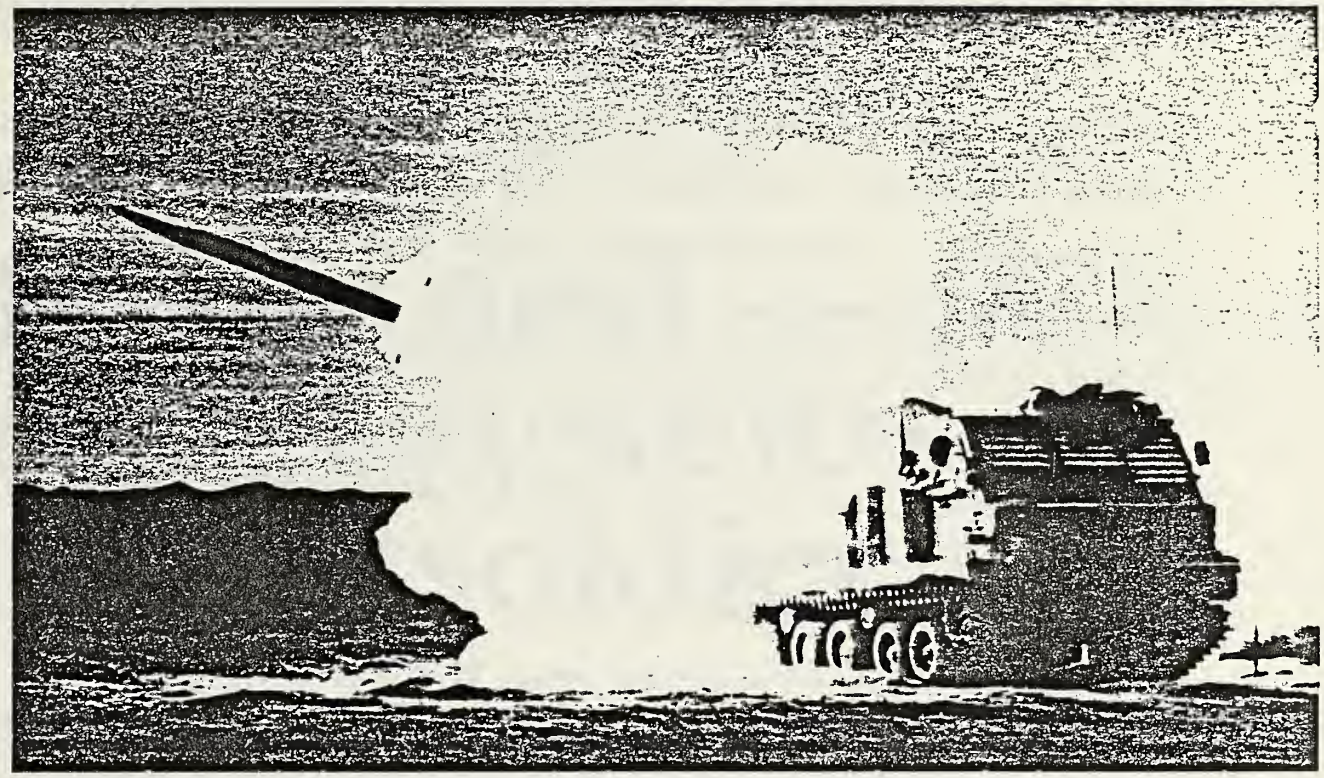
While the U.S. dropped its Multiple Artillery Rocket (MAR) Program in 1969, the FRG continued, and developed and fielded the Light Artillery Rockets System LARS. The British and Italians later joined with the FRG in initiating

the RS-80 effort - a system designed primarily for delivery of scatterable anti-tank mines (AT-2) to a range of 60 km. Development was suspended in 1975, however, when the UK and Italy withdrew because of high cost estimates for production, and logistics.

Related activities in France involved the initiation of development by Aerospatiale of a multi-purpose rocket system - designated the Syra - for delivery to a range of 20-22 km. The Syra never went into production though, because of high acquisition cost. Later in the 70's another French firm, Societe' Europeenne de Propulsion (SEP), has been developing a barage rocket system, designated the Rafale with a maximum range of 32 km. A prototype of the Rafale was reportedly completed in mid-1979 while SEP continued work on developing a longer-range, heavier warhead version.

This has been primarily an industrially funded effort, but the French government has contributed funding as well. Even though the Rafale family was not being developed at the request of French military authorities, but primarily with exports in mind, SEP hoped that the French military would become interested in the early 80's.

As the Anglo-French variable geometry (AFVG) fighter and NATO PHM projects have shown, such on-going national alternative solutions are an ever present threat, even when they offer substantially less in technical performance and greater cost.



MLRS now operational with the U.S. Army.

Fielding of MLRS gives Army artillery more mobile firepower than ever before.

It ripple-fires 12 rockets in less than a minute. The rockets reach targets up to 30 kilometers away. They can plaster those targets with thousands of specific-mission submunitions—grenades and shaped charges or anti-tank mines or terminally guided, anti-armor warheads.

This is the Multiple Launch Rocket System (MLRS). It's designed to neutralize massed attacking forces. The first operational MLRS unit is a battery of nine launchers assigned to the 1st Infantry Division. Other divisions in the U.S. and Europe also now have MLRS. It gives Army artillery more mobile firepower than it has ever had before. MLRS will also become operational in the French, German, British and Italian armies.

MLRS can launch a tidal wave of defensive fire, yet it is dependable and easy to operate. That's why it's called the "Soldier's System". The fire control display communicates in plain language instead of code. Chassis and running gear are the same as those in the U.S. Army's Infantry Fighting Vehicle (IFV).

MLRS is another way we're keeping the United States ahead in tactical missiles. LTV Aerospace and Defense, Vought Missiles and Advanced Programs Division, P.O. Box 225907, Dallas, Texas 75265.

LTV Aerospace and Defense
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The GSRS system, now the MLRS, through the redirection of the program, was to be adapted to accommodate German needs by slightly increasing the size of the rocket as required to adapt to the German warhead, the AT-2. The redirection stretched the earlier development and validation schedule by three months, from 29-32 months.

Completion of the validation phase of development by selection of a winning contractor took place in May 1980. Vought won. At this point, per the MOU, the maturation phase of development begins and the French and British had 90 days to each provide the first of their annual $5 million contributions for 1980, 81, and 82 - or drop out. Prior to this date the U.S. government covered all costs, except for the development under contract to the German government of the AT-2 warhead.

The goal for the U.S. commitment to the validation phase was established at $146 million. Upon approval for the commencement of the maturation phase by the U.S. government and the Joint Steering Committee, the U.S. was to commit another $102 million. With the $30 million provided collectively by the UK and France the total development commitment came to $278 million. The goal for the FRG's commitment to development of the AT-2 was established at DM 96 million. For German expenditures in the U.S. on this project, the goal was also $15 million, but any cost growth in this portion exceeding 15% was to be borne by the U.S. For both the $278 million and the DM 96 million the threshold commitment was to be 115% of the goal (escalated for economic conditions), a forecasted breach of which would cause the U.S. or FRG to consult the other participants.

From Vought:

Missile and rocket systems for the soldier.

Vought produces extremely accurate, hard-hitting, rapid-firing and highly mobile missile and rocket systems for the U.S. soldier.

First we produced *Lance* — the Army's field artillery missile system — on time and within budget. *Lance* lets the artilleryman hit fast. Hit hard. And right on the target.

Then we pioneered artillery missile dispensing warhead technology with early design development and flight tests of the Army's Terminally Guided Submissile (TGSM) effort.

Now Vought will produce the Army's Multiple Launch Rocket System (MLRS). The MLRS — known as the "Soldier's System" — is an artillery system employing a tracked, mobile launcher which can fire, without reloading, up to 12 rockets in rapid succession at a range of 18 miles. MLRS will deliver massive defensive firepower for the U.S. and its allies to neutralize attacking forces and their equipment.

Now, too, our T-22 *Lance*-sized missile has been successfully flight tested in the Army's Simplified Inertial Guidance Demonstration (SIG-D). And we'll provide six T-22 missiles for the Defense Department's Corps Support Weapon System flight test program. The T-22 solid-propellant long-range missile is designed to give the soldier reliable defensive fire against second echelon armor and light materiel targets.

Missile and rocket systems for the soldier. From Vought.

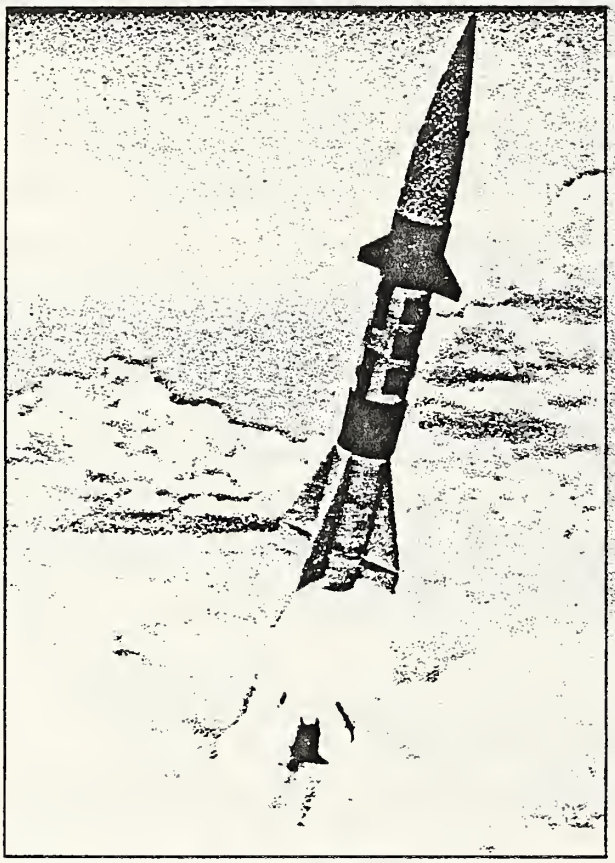


VOUGHT an LTV company

From the people who produce field artillery systems — on time and within budget.

Vought's commitment to the missile business spells outstanding career opportunities for engineers now — and in the years ahead. For complete information on what we can offer you in the exciting world of missile and rocket system engineering, write us today. Vought Corporation, Professional Placement, P.O. Box 225907, Dallas, Texas 75265.

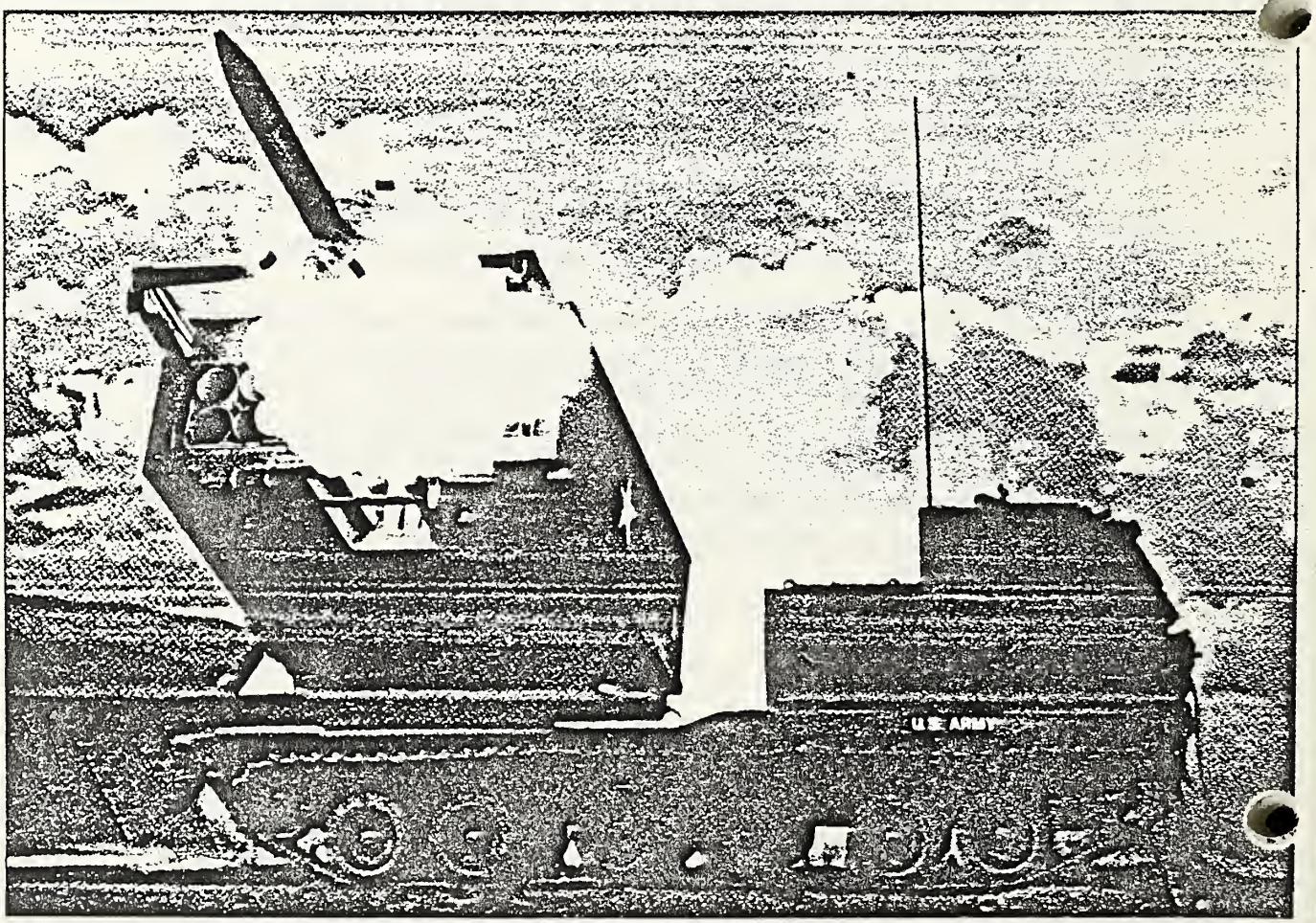
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T-22 Missile for Corps Support Weapon System



Lance Battlefield Missile



Multiple Launch Rocket System (MLRS)

The royalties towards recouping development costs that were to be added to the base price of U.S. developed items procured by the European participants for their own defense purposes were not to exceed 3% if procured from U.S. sources; and are not to exceed 5% if procured from European sources. Reciprocal provisions would apply to procurement by the U.S. of European developed items. The $15 million to be committed by each of the European participants actually electing to join in mid-1980 would be credited towards their royalty payments to the U.S. - or if not exhausted (due to decrease in order) then forfeited.

The royalty on third country sales was to be determined by the selling participant but would not exceed 8% for sales to other NATO members and would not be less than 8% for sales to non-NATO nations.

Of the approximately 200 fire units and 250,000 rockets required by the three original European signatories to the MOU, the FRG planned to procure 65%, France 25% and the UK 10%. After some jockeying for position between French and German aerospace industries over the location of the European production line, it was agreed initially that the line would be in France (presumably to accommodate the two nations' conflicting 3rd country sales positions). So as to allow all three nations to participate in management it was expected in early 1980 that a Groupement d'Interet Economique (along the lines of Euromissile) would be established under French law.

In accordance with the objective stated in the MOU to divide production among the participants... "in so far as feasible and economical, between U.S. and European contractors or agencies over the life of the system on the basis of national off-take for national defense purposes..." The Europeans were considering procuring the U.S. Army/FMC Infantry Fighting Vehicle from the U.S. source. In return the U.S. would procure some of its pods and rockets for its European forces from the European source.

c. The European Production Program

Six and one half years after the signing of the original MLRS MOU in mid 1979 by the U.S. and its principal European allies, it appeared that an agreement had been reached for the European Production Program. Signature of second MOU amongst the European partner governments - since joined by Italy - was reportedly imminent in the fall of 1985. The planned requirements/order share amongst the four breaks down as follows:

	FRG	Great Britain	France	Italy	Total
SPLL	200	67	55	20	342
M-77 rockets	65,000	48,000	32,000	5,400	150,400
AT-2 rockets	20,000	-	-	600	20,600
Program share [1]	50%	26%	18%	6%	100%

[1] without specific AT-2 parts, i.e. warhead and its integration

Due to the predominance of the Bundeswehr's share, the FRG was ultimately agreed to as the pilot nation, and its Federal Office for Military Technology and Procurement (BWB) has begun functioning as the Executive Agency (EA). The production phase MOU, was to be signed this autumn.[223]

This of course was preceded by the usual debate over whether it would be better to create an international program office similiar to the German-French BPFA, for the HOT and MILAN and Roland missile programs, or the even more integrated approach utilized with the creation of NAMMO for the MRCA Tornado.

By the beginning of 1986 the number of officials in the project office was to be increased from the present 13 to 27. This staff will include a British, a French, and an Italian liaison official, and translators. The manager of the project office is Dipl.-Ing. Manfred Kimmerich. As European Production Co-ordinator, and member of the European Executive Management Committee (EEMC), he will require the concurrence of his colleagues for each decision. The EEMC reports to the European Steering Committee (ESC); below the EEMC are several working groups, such as the Production Planning Working Group (PPWG). Although the official language in this office has been German, most of the data comes from the U.S. As a result English is becoming more and more important.[224]

On the industrial side, the MLRS-EPG (Europaische Produktionsgesellschaft mbH — European Production Company), at Ottobrunn near Munich, was founded as a consortium by the national managing firms selected by the governments. These

firms each have a share of the work that roughly corresponds to each country's share in the overall program. The firms have shares as follows: Diehl-60%, Hunting Engineering-20%, Aerospatiale-14%, and SNIA BPD-6%.

Originally, the 60% now the responsibility of Diehl was to have gone to RTG, the joint subsidiary of Diehl and MBB. However early in 1985 it became clear that MBB, in contrast to Diehl, would only have a small share of the production program. MBB therefore, pulled out, and Diehl assumed the RTG share.

The EPG industrial team has been working on its proposal for a European production program since 1982. Since the German BWB demanded competition at the component level, the EPG requested manufacturing bids from the approximately 100 firms in the European partner nations that the governments had nominated to the project office.[225]

These firms submitted their original offer without the details of how they were calculated. Competition was important in the MLRS program due to the self imposed constraint that European manufacture was not to be more expensive than the American one (even though the production volume was to be smaller). Because the cheapest offer is not always the most reliable and most effective the EPG had to enter into extensive analysis and negotiation. In addition, each country demanded participation in the program commensurate with its order volume in both quality and quantity.

At the end of 1983, the EPG submitted to the BWB its proposal for dividing manufacturing responsibility. This proposal represented an attempt to provide fair economic and technological participation to each national industry. Nonetheless, this proposal, although feasible, was rejected, because it did not fit with the political intentions and conditions prevailing in some of the countries.[226]

Great Britain desired greater participation for its national armament industry. The FRG wished to have single-source manufacturing exclusively, which turned out to be an impossible request, since it would have led to France's being the sole deliverer of rocket engines. Those industrial firms that felt themselves to have been discriminated against voiced their concerns - not without some success.

In the spring of 1985, after the government representatives from the partner countries had met numerous times, and the EPG had submitted a new proposal for dividing program responsibility, a general accord was reached. In addition, an important roadblock was removed at the government-to-government level when the British finally agreed to invest an additional 20 million in the project — so that the dual-source bomblet manufacture which they favored would not be more expensive than single-source manufacture.[227]

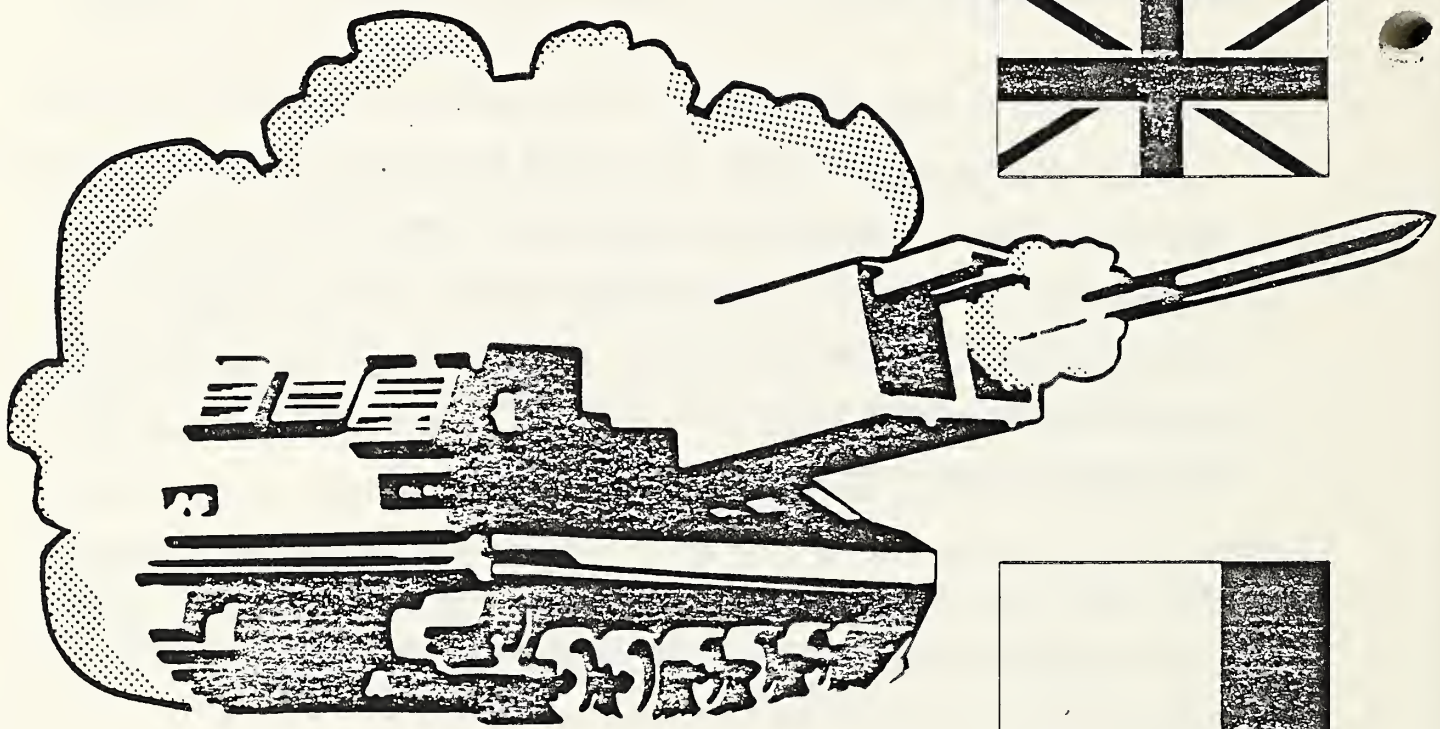
The EPG's prime contractor responsibility for second source production in Europe covered 36 work packages. The major subsystem contractors with which the EPG will sign subcontracts directly are:

MLRS

Multiple Launch Rocket System

Basic system developed by Vought

The new artillery system for forward defence



MLRS-EPG

MLRS-Europäische Produktionsgesellschaft mbH

EPG – a joint company of Diehl, Hunting Engineering, Aerospatiale and SNIA-BPD for the European production of the MLRS system.

Several firms have the main responsibility for certain areas in dealing with the EPG:

- o Diehl for the rockets;
- o Thyssen-Henschel for the carrier assembly;
- o Aerospatiale for the integration of the self propelled launcher/loader (SPLL), in the co-operation with Wegmann;
- o Rheinmetall for the bomblets;
- o SNIA BPD-for the rocket motors.

There are four main lines or integration:

- o Diehl for the launch pod container(LP/C);
- o Thyssen Henschel for the carrier;
- o Wegmann for the SPLL, including the vehicle and weapon system mount and the fire control system, for the Budeswehr;
- o Aerospatiale for the SPLLs for the other armed forces.

Additional work packages include:

- o rockets, which make up approximately 75% of the entire volume of orders (not including the parts specifically for the AT-2 mines):
- o the bomblets are from Rheinmetall, with delivery from Royal Ordnance Chorley; SNIA BPD in Italy, with SNPE in France as the sub-contractor, who will manufacture the rocket motor. The motor housing will come from Lucas, a British firm. Diehl will have responsibility for the warhead integration, and MBB will deliver the fuze for the warhead.

- The launcher, including the vehicle, will make up 25% of the entire order volume: the hull will come from France's GIAT, Royal Ordnance Leeds will deliver the cabin, David Brown will build the hydraulic transmission, and the Diesel engine will come from the U.S. manufacturer, Cummings. Wegmann will build the cage that contains the LP/C, Aerospatiale will manufacture the turret base, and Marconi (MCCS) and the GEC Avionics will manufacture the fire control system and stabilization platform. Great Britain is thus receiving a great deal of responsibility in the area of electronics, but it does not have a final line of integration.[228]

There are thus dual-source production and integration in only three cases: for the manufacture of the bomblets, for the SPLL integration, and for the rocket motor. In each case, the firms had to submit a common offer, with one company serving as the main contractor.

In contrast to the American programme where Vought receives the bomblets and vehicles as Government-furnished equipment (GFE), the EPG must contract for this equipment.[229]

Below is a detailed breakdown of work sharing for the European production of the MLRS:

LP/C Loaded	Diehl	FRG
LP/C Structure	Aerospatiale	France
Launch Tube	MBB	FRG
LP/C Assembly	MBB	FRG
Fuze	MBB	FRG
Harness/Flex W/HSG	Hughes Micro-Electronics	UK
Warhead Assembly	Diehl	FRG
Warhead Structure	RO Birtley	UK
Foam Supports	ICM	UK
Bomblet Assembly (1 +)	Rheinmetall	FRG
Bomblet Assembly (2)	RO Chorley	UK
Rocket Motor (1 +)	SNIA - BPD	Italy
Rocket Motor (2)	SNPE	France
Rocket Motor Case	Lucas	UK
Nozzle	ICM	UK
Igniter	GIAT	France
SPLL Assembly (1 +)	Aerospatiale	France
SPLL Assembly (2)	Wegmann	FRG
Cage	Wegmann	FRG
Electrics	Aerospatiale	France
Turret/Base	Aerospatiale	France
Launcher Drive System	Vickers Systems	FRG
Azimuth Drive	Western Gear	UK
Fire Control System	Marconi (MCCS)	UK
SRP	GEC Avionics	UK

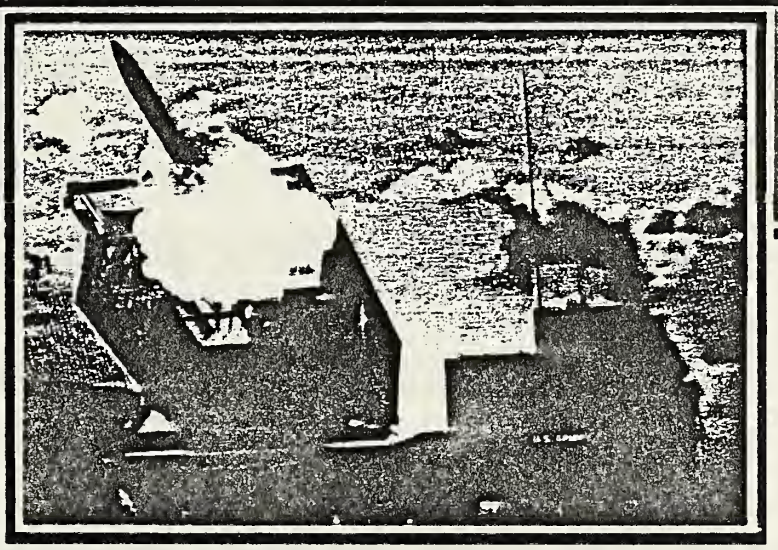
Carrier Assembly	Thyssen Henschel	FRG
CAb	RO Leeds	UK
Hull	GIAT	France
Transmission	David Brown	UK
Track	Creusot-Loire	France
Final Drive	Thyssen Henschel	FRG
Power Take Off	Thyssen Henschel	FRG
Battery	Hagen	FRG
Engine	Cummings	US

The first contract was to be awarded by the BWB in late 1985. It will be for the production facilitation phase (the PFP), with an option for the entire manufacture. The preparation for production includes the manufacture planning, the setting up of the assembly lines, the ordering of long lead-time parts, and the manufacture of pre-production equipment and pilot lots. The contract will be comprehensive, because it gets into the details of manufacture, and specifies the start-up spare parts supply, the management organization, quality assurance, lot acceptance, packing, transport, import duties, insurance, and the comprehensive qualification of the assembly line, which in Europe is quite complicated. Three launch pods will be taken out of each lot of a maximum of 3,000 rockets (500 launch containers), and there will be ballistic test with the rocket, in order to produce reliable failure quotas.[230]

The contract specifies two production periods: from 1989 until 1992, and from 1993 until 1996. This is a compromise taking the budget procedures of each of

THORN EMI IS THE UK NATIONAL PRIME CONTRACTOR IN CONSORTIUM TO DEVELOP MLRS TERMINALLY-GUIDED WARHEAD

SEE US ON STANDS A2y & A30
ASIAN AEROSPACE 86



A new terminally-guided warhead is being developed to enhance dramatically the all-weather, anti-armour capability of the Multiple Launch Rocket System (MLRS). THORN EMI Electronics is a member of the four-nation MDTT consortium and is the UK National Prime Contractor.

THORN EMI Electronics brings to the programme directly relevant expertise in radar and seeker technology at millimetric frequencies, proximity fuzing, and ultrasonic and radar scale modelling as well as in system design, simulation, assessment, engineering and telemetry for weapon trials.

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the four countries into account. During the production periods, the project manager will release annual allocations. Most likely, the industry will learn of the size of the yearly allocation for the launcher 24 months in advance. For the rockets, the information will be given 12 months in advance.[231]

The overall cost of the European license program will amount to approx. DM 5 billion, not including the German AT-2 warheads, which will cost about DM 1 billion.

The first MLRS systems from the European production are scheduled to be fielded in the fourth quarter of 1988. The FRG and Great Britain will receive the first deliveries. The full rate of manufacture of 72 launchers and approximately 30,000 rockets yearly will be reached beginning in 1990. Two years later, it will begin to decline, and it will end in 1996 - unless there are additional MLRS orders from other countries.

But first, governments will sign an MOU for manufacture which will contain a fully, detailed description of the work sharing agreement. It will be based on value and be subject to re-negotiation every two years. Payment will be made in national currency - the countries will transfer money, in their own nation currencies, to accounts in the FRG, and the BWB will arrange for payment to industry as the work proceeds. Together with this inter-European MoU, a supplement to the basic MOU with the U.S. will be signed. It will concern production details and export regulations.[230]

This MOU supplement will then form the basis for the activities of the MLRS International Corporation (MIC), which Vought and the EPG will found in the U.S. to market the system. Exports are to be divided in a ratio of 65 to 35 between the U.S. and Europe. This ratio is likely to be achieved only over the long-term, however, since it is not possible to prescribe to potential clients where they should place their orders. In addition, one partner or the other may give up a share in the production, if a potential client demands offsets. This could, for example, be the case with the Netherlands, which is showing interest in MLRS, and which might wish to have a share in the production of the bomblets. For sales to non-NATO, countries, the U.S. naturally has a veto right. In addition, a European country may veto the sale of the system by another European country. In such a case, however, the Americans would still be able to make a delivery, so that the single veto power of the Americans may become an important factor in European export considerations.[233]

The basic condition for European participation in the export of the MLRS is naturally a competitive price in comparison with the U.S. Experience suggests that the SPLL may actually turn out to be somewhat less expensive in Europe, and there are no substantial differences concerning the rockets - at least based on the exchange rate of the dollar in the spring of 1985.

Another positive sign is that the Americans have not established a second MLRS assembly line in the U.S. The reason for this is probably the European manufacture. Perhaps it may even turn out to be possible as with the German-American agreement for the Rolling Airframe Missile (RAM) to qualify the European manufacture as a second source for the U.S.[234]

The U.S. and the European countries also plan to cooperate on a common logistics network for MLRS in Europe, through the NATO Maintenance and Supply Agency (NAMSA) in Luxembourg. NAMSA's request for proposals to the industries of the partner countries will reveal how economically competitive the European countries are. Certainly, the American partners will not get all the contracts, since NAMSA also has the task of making sure they are distributed to all the customer nations.

The AT-2 mine warhead will not be a part of the international work sharing. The EPG will still be the main contractor, but the manufacture will take place only in Germany. Dynamit Nobel will manufacture the AT-2 mines, which are also fired from the LARS 110 mm artillery rocket launcher.[235]

The AT-2 rocket may be fired from all MLRS launchers. Thus far, only Italy has decided to procure it - a small order of only 60 rockets. The interest of the U.S. and Great Britain has reportedly grown, now that difficulties with faulty currents in the warhead have been overcome.

By the end of 1985, all agreements and contracts for the European manufacture should be complete: the MLRS Phase I program (SPLL, bomblets, and practice rocket), and the MLRS Phase II (AT-2 rocket) program.

The next step will be the development for the MLRS Phase III, for the rockets with terminally guided sub-munitions, which has now begun on a transatlantic basis with the participation of the U.S., Great Britain, France and the FRG.

The pilot country for the development will be the U.S. This munition will not be ready for fielding, however, until the middle of the 1990s.[236]

[1]One other project involved in this Mode but not treated in this paper is the license production of the USN's Mk. 44 torpedo in Italy and France for their respective navies.

[2]Hochmuth, Milton S., Organizing the Transnational: The Experience with Transnational Enterprise in Advanced Technology, A. W. Sitjhoff, Leiden, Netherlands, 1974 (hereinafter referred to as Organizing the Transnational) pp. 22-3.

[3]As Vandevanter pointed out in his 1964 Rand study Coordinated Weapons Production in NATO: A Study of Alliance Processes, p. 43-44, U.S. government clout, exercised through inducements such as the waiver of royalties and license fees, providing of technical assistance, and the possibility of ordering a number of the systems for distribution through MAP, were known to have been influential in weaning Continentals away from the British Bloodhound missile.

[4]This special position of the U.S. later proved to be an irritant in the program. Subsequently, in December, the Working Group set up an Industrial Conference, one consisting of representatives from each of the NPC's, whose task it was to come up with organizational solutions for industry.

[5]Ibid., p. 29.

[6]Milton S. Hochmuth is very heavily quoted throughout this section on the NATO Hawk.

[7]Hochmuth, Organizing the Transnational, p. 28.

[8]In the negotiation of the agreement to get the program underway, the International Staff tended to be more active in both the Hawk and the Sidewinder missile programs than it did in the three following joint production programs: the Bullpup AS missile, the Mark 44 anti-submarine torpedo and the F-104G Starfighter.

[9]In order to initiate the program the U.S. was bearing the major financial liability until full arrangements could be agreed to between the PG's.

[10]As we will see later, U.S. industry eventually got a proportionally higher share.

[11]It was not until 1962, however, that the legal status of these NATO chartered organizations was finally settled.

[12] Finding and training suitable personnel continued to pose difficulties for the European firms for the next several years.

[13]Hochmuth, Milton S., Lt. Colonel, USA, Management Problems in the Multinational Production of Weapon Systems: The NATO Hawk Program, Industrial College of the Armed Forces, Washington, D.C., 30 March 1963 (hereafter referred to as The NATO Hawk Program).

[14]AC/139 means Allied Committee #139—in this case the NATO Hawk Working Group, and D/8 designates which document is referred to.

[15]Hochmuth, Organizing the Transnational, p. 27.

[16]The other of NATO's first two weapon system programs, the Atlantic, skirted this issue by using the other principal alternative approach, a national agency, France's D.T.I.A., to contract for and manage the project under the international supervision of a NATO Project Steering Committee.

[17]Hochmuth, The NATO Hawk Program, p. 28.

[18]Lord Ismay, NATO - The First Five Years, 1949-1954, Bosch-Utrecht, Netherlands, 1954, p. 60.

[19]Notice Ismay's use of the word Council in the plural, emphasizing that NATO is more a reaction vessel for national ideas, than a true decision making body.

[20]Chatham House Study Group, Atlantic Alliance, NATO's Role in the Free World, Royal Institute of International Affairs, London, 1952, p. 93, quoted in [21]Hochmuth, Organizing the Transnational, p. 47.
Hochmuth, Milton, S., Management Problems in Multinational Production of Weapon Systems: The NATO Hawk Program, 1963, p. 14.

[22]Hochmuth, M. S., The NATO Hawk Program, 1963, op. cit. p. 35.

[23]The NHMO, or Bureau de Gestion Hawk, is still a going concern as of 1980, having managed in the interim the maintenance and supply of spare parts for the deployed systems and a series of European improvement programs all together totaling well over $1 billion in contract awards since the original program.

[24]This post was held by Georges Wenisch who is heavily quoted in this subchapter.

[25]Hochmuth, Organizing the Transnational, p. 40.

[26]Hochmuth, The NATO Hawk Program, p. 28.

[27]Hochmuth, Milton S., Organizing the Transnational p. 40.

[28]Ibid., p. 46.

[29]Ibid., p. 47.

[30]Ibid., p. 47.

[31]Ateliers de Construction Electrique de Charleroi.

[32]Hochmuth, The NATO Hawk Program, p. 24.

[33]See Chapter 12.

[34]Hochmuth, The NATO Hawk Program, p. 25.

[35]Though originally there was to be a weighted voting system, as with the NATO Hawk BOD, the unanimity rule prevailed.

[36]Hochmuth, The NATO Hawk Project, p. 36-37.

[37]Hochmuth, Organizing the Transnational, p. 45.

[38]Ibid., p. 54.

[39]Ibid.

[40]Ibid, p. 55.

[41]Ibid.

[42]Ibid, p. 48.

[43]Ibid., p. 41

[44]Ibid., p. 55.

[45]Ibid., p. 48.

[46]Hochmuth, Organizing the Transnational, p. 182.

[47]Ibid., p. 183.

[48]Ibid.

[49]Ibid., p. 184.

[50]Ibid.

[51]Wenisch, Georges, Organization des Programmes Internationaux de Production Integree II, p. 27, Institute of Sociology, University of Liege, Belgium, 1967.

[52]Angles d'Auric, Henri, Organization des Programmes Internationaux de Production Integree, p. 30, Institute of Sociology, University of Liege, Belgium, 1966.

[53]Ibid.

[54]Ibid., p. 56.

[55]Hochmuth, Organizing the Transnational, p. 48.

[56]Ibid., p. 49. The NADGE Project's inter-firm company set up to manage the project, NADGECO Ltd., though in fact run by the US firm, Hughes (35%), never suffered from this image problem.

[57]Ibid., p. 49.

[58]This evidently turned out to be to Raytheon's advantage, when considerable problems later developed with the rocket motor.

[59]This problem of cost surveillance accompanying government contracting later resurfaces in such transatlantic programs as the F-16 and initially for AWACS where a U.S. Government agency served as the procuring authority for the F-16 (FMS) or the procuring agent for a direct purchase by an NPLO, as in AWACS.

[60]A. H. Cornell, An Analysis of International Collaboration in the Organization and Management of Weapons Coproduction, American University, Washington D.C., March 1969, distributed by NTIS, p. 396.

[61]Angles d'Auriac, op. cit., p. 20.
Angles d'Auriac's complaints sound very much like those of the US co-licensees for the Franco-German Roland missile system, Hughes and Boeing, in the mid-70's.

[62]Ibid., p. 456.

[63]This original perception of the Mandate by the NPC's is also highly illustrative of their perception of the role that the international prime contractor, SETEL, was to play.

[64]Ibid., pp. 455-456.

[65]Again, the US Roland program echoed these problems in the mid-70's.

[66]Hochmuth, Organizing the Transnational, p. 38.

[67]Angles d'Auriac, p. 20.

[68]Ibid.

[69]Hochmuth, Organizing the Transnational, p. 45.

[70]The penalty never exceeded 5%, being only 1.26% for a delay of four months.

[71]Wenish, op. cit. p. 34.

[72]Besides the inevitable rise in costs in this period and the documentation/continuous development problems, the original estimates failed to take account of the purchase of concurrent repair parts costing $63 million.

[73]Although the U.S. government never insisted that its share of reimbursable assistance funds (i.e. those funds contributing to the purchase of the Hawk system for Greece and Denmark) had to be spent in the U.S., as of September 1964, total disbursements to U.S. industry were estimated unofficially at around $60 million more than the U.S. government's financial contribution.

[74]See NHPO subsection.

[75]Such agreements are generally referred to as protocols or Memoranda of Understanding (MOU's) throughout this paper.

[76]Hochmuth, The NATO Hawk Project, p. 30.

[77]Ibid., p. 29.

[78]Hochmuth attributed this obstinate stand in part to France's large weapons development, production, and procurement bureaucracy, coupled with her quest for pre-eminance—a point that could be periodically leveled against the U.S., as well, in other weapons projects.

[79]Hochmuth, Organizing the Transnational, p. 41.

[80]Hochmuth, Organizing the Transnational, p. 46-47

[81]In reality each contract was formed by the grouping of five closely related contracts between the five PG's and SETEL, the date of coming into force being that of the date of notification of all others by the last one to have signed.

[82]On 19 January 1962 a rider serving as a joinder between the preliminary contract and the production contract was signed. It covered the final preparation for production as well as the assembly of the first limited series.

[83]Wenisch, op. cit., p. 30

[84]Ibid., pp. 30-31.

[85]Ibid, p. 32.

[86]Ibid.

[87]Ibid.

[88]Ibid. p. 33.

[89]Ibid, p. 33

[90]The two-year supply of repair parts was integral to the original production order, but as is often the case with high-technology systems considerable additional quantities were soon needed.

[91]Cornell, op. cit., p. 422

[92]Ibid., p. 425

[93]Ibid.

[94]Hochmuth, Organizing the Transnational, P. 52

[95]Ibid.

[96]Ibid., p. 53

[97]Ibid., p. 50.

[98]Ibid., p. 50-51.

[99]Ibid., p. 51

[100]Ibid., p. 55.

[101]Ibid., p. 50.

[102]Again, HELIP is covered in Chapter 12.

[103]Robert Rhodes James, Defense, Technology and the Western Alliance, Vol. 3: Standardization and Common Production of Weapons in NATO, The Institute for Strategic Studies, London, 1967, p.14.

[104]Bundesamt fuer Wehrtechnik und Beschaffung (Germany's Federal Weapons Technology and Procurement Office).

[105]Vandevanter reported that the FRG had reached a decision several months earlier, but in light of the political significance of the order, had held up the announcement at the insistance of the French, who were afraid that the loss of face caused by the German rejection of the Mirage II might topple the de Gaulle government. France, on the verge of civil war at the time was saved by deGaulle's return and establishment of the Fifth Republic in late 1958.

[106] Brigadier General Elliott Vandevanter, Jr., USAF (Ret.) Coordinated Weapons Production in NATO: A Study of Alliance Processes, The Rand Corporation, Santa Monica, Calif., 1964, p.42.

[107]Vandevanter, op. cit. p. 42.[108] Vandevanter, op. cit. pp. 53-4.

[109]Aviation Week & Space Technology, September 2, 1969, p. 20.

[110]These four nations, though not participating in the F-104G production effort, did participate in production of the Sidewinder AIM-9B Missile, with which the F-104G was armed. Denmark and Norway did participate in the F-104G replacement production effort however, the F-16.

[111] A.H. Cornell, An Analysis of International Collaboration in the Organization and Management of Weapons Coproduction, American University, Washington D.C., distributed by NTIS, March 31, 1969, p.535.

[112] Ibid., p.537.

[113]Vandevanter, op. cit., p. 53.

[114]Cornell, op. cit., p.542.

[115]Andre Regout, "Le Programme F-104G", Secretaire General de Fabrique Nationale, Organization des Programme Internationaux de Production Integree, Universite de Liege, 1964, pp. 50-51.

[116]Ibid., p. 614.

[117]Ibid., pp. 541-3.

[118]Ibid., pp. 564-5

[119]Ibid., p. 565.

[120]Ibid., p. 544.

[121]Ibid., p. 545.

[122]Ibid., pp. 544-5.

[123]Ibid., p. 570.

[124]A major modification for a new reconnaissance version of the aircraft, and two electronic improvements, one to the bombing computer, and one for the inertial navigation equipment, were exceptions that did cause considerable disruptions, however.

[125]Cornell, op. cit., p. 546.

[126]Ibid., p. 559.

[127]Ibid., pp. 546.

[128]Ibid., p. 547.

[129]Ibid., pp. 547-8.

[130]Aviation Week, January 16, 1961, p. 32.

[131]Cornell, op. cit., p. 548.

[132]Cornell op. cit. p. 595.

[133]Regout, op. cit.

[134]Actual deliveries were reduced to 947, due to loss of two aircraft during testing.

[135]Lockheed's production was outside the consortium.

[136]Regout, op. cit., p. 43.

[137]One must remember, that in addition to the favorable work shares of the three smaller participants, the U.S. paid through MAP for: 40% of the Italian order; 21% of the Dutch order; and 25% of the Belgian order.

[138] Gen. Robert Bureau, "Le Programme F-104G," Organization des Programmes Internationaux de Production Integree II, Universite de Leige, 1965, p. 49.

[139]Cornell, op. cit., p. 553.

[140]Cornell, op. cit., p. 568.

[141]Ibid., p. 598.

[142]Ibid., p. 546-7.

[143]Ibid., p. 556.

[144]Ibid., p. 561.

[145]Ibid., p. 562.

[146]Andre' Regout, Chairman of Fabrique Nationale used the expression "parfois inquietant" to qualify these clauses.

[147]Regout, op. cit., p. 47.

[148]Ibid., p. 49

[149]Ibid.

[150]Ibid., p. 49

[151]Ibid, pp. 46-8.

[152]Robert Bureau, op. cit., p. 44.

[153]Cornell, op. cit., pp. 561-2.

[154]Ibid., p. 587.

[155]Regont, op. cit.

[156]Ibid., p. 563.

[157]Ibid.

[158]Ibid., pp. 563-4.

[159]Ibid., pp. 599-600.

[160]Ibid., p. 600.

[161]Ibid.

[162]Ibid., p. 583.

[163]Cornell op. cit. pp. 595-6.

[164]James, op. cit, p. 16.

[165]Robert Rhodes James, Defense, Technology, and the Western Alliance, No. 3: Standardization and Common Production of Weapons in NATO, The Institute for Strategic Studies, London, July 1967, p. 18.

[166]Ibid.

[167]Ibid.

[168]Ibid, p. 19.

[169]Ibid.

[170]FGW, or as of more recently, BGT is 95% owned by a U.S. firm, Perkin-Elmer Corp. of Connecticut.

[171]Brigadier General E. Vandevanter, Jr. USAF (Ret.), Coordinated Weapons Production in NATO: A Study of Alliance Processes, The Rand Corporation, November 1964, p. 37.

[172]Ibid., p. 38. (note that neither the Hawk nor the F-104G project had a "lead nation" from which a firm was selected to be prime contractor.)

[173]Organization des Programmes Internationaux de Production Integree II, "Le Programme Sidewinder," M. K. Halsne, Institution de Sociologie de l'Universite de Liege, 1965, pp. 61-2.

[174]Ibid., p. 64.

[175]Ibid., p. 62.

[176]Ibid., p. 65.

[177]Ibid., p. 63.

[178]Ibid., p. 64.

[179]Ibid., p. 67.

[180]Ibid., p. 66.

[181]Raytheon Brochure.

[182]"Germany, Under Licensing Agreement, to Build 9000 AIM-9L Sidewinders," Aerospace Daily, January 23, 1978, p. 101.

[183]Harold J. Roop, "Sidewinder," National Defense, Sept.-Oct. 1978, p. 30.

[184]John E. Severence, Raytheon, Public Relations letter to the author, November 5, 1979.

[185]Roop, op. cit, p. 31

[186]The Taildog was slightly modified at a later date and was redesigned SRAAM75.

[187]W. Schenk, "The AIM-9L Super Sidewinder: NATO Standardization in Practice," International Defense Review, 3/1976, p. 366.

[188]Even if the interested nations had been able to agree on a common system, tdisproving the lessons of the LWSR fighter competition, the Atlantic projet, NBMR's 3 & 4 (all Chapter 5) and others he fate of the NATO PHM project (Mode #5, Chapter 10) would suggest that the second part of this plan, joint funding of unilateral development in one nation, followed by license production in all others (the U.S. government's interdependent development policy), was unsound as well.

[189]Schenk, op. cit.

[190]This was a very real issue at this time for the FRG, since during this same period of 1976 and early 1977, the FRG was facing the serious prospect of the U.S. unilaterally cancelling another U.S.-FRG program, wherein all the development effort was taking place in the U.S., the NATO PHM.

[191]Ibid., p. 367.

[192]Ibid., p. 365.

[193]Ibid., p. 367.

[194]Ibid.

[195]Ibid., p. 369

[196]The fuze is produced by Hughes' Santa Barbara Research (with Martin as a second source contractor). There has been, however, as of late 1979 some discussion as to the possibility that the fuze too, might eventually be released for production in Europe.

[197]The FRG and UK are both acquiring their initial AIM-9L's off the U.S. line. As of January, 1978, the FRG was to buy 500 AIM-9L's from the U.S. and build 9000 under license.

[198]Due to budgetary problems, Italy will not be able to replace its older missiles as fast as its other MRCA/AIM-9L partners.

[199]A navy spokesman admitted to the Aerospace Daily that the Europeans could naturally reverse engineer the fuze, but this would take time. The U.S. apparently will not ship fuzes overseas until the German-built missiles are completed and ready to be fitted with them.

[200]The U.S. government finally agreed to this release of data by the FRG to the other European participants in June, 1980.

[201]Interview with Raytheon's Guy DesLoovere, November, 1979

[202]Ibid.

[203]Ibid.

[204]Ibid.

[205]Ibid.

[206]"NATO Working Group Studying Way to Acquire Patriot for European Air Defense," Aerospace Daily, March 7, 1979, page 33 (hereinafter referred to as "NATO Working Group").

[207]Raytheon Brochure.

[208]"NATO Working Group," op. cit.

[209]Patriot RSI Progress Report by the Patriot Project Office's Assistant Program Manager, International Operations, DARCOM, Redstone Arsenal, Alabama, late 1979

[210]This European modernization of the Improved Hawk is called Hawk-PIP. See Chapter 12 for further information.

[211]Patriot RSI Progress Report, op. cit.

[212]Rationalization, Standardization, and Interoperability

[213]Patriot RSI Progress Report, op. cit.

[214]Ibid.

[215]Ibid.

[216]Ibid.

[217]"NATO Working Group," op. cit.

[218]Patriot RSI Progress Report, op. cit.

[219]Ibid.

[220]"European Consortium for Copperhead," International Defense Review, 2/1980, p. 170.

[221]Ibid.

[222]Ibid.

[223]Wolfgang Flume, "The European MLRS Programme: Finally, a Signed MOU," Military Technology, 10/85, p. 146.

[224]Ibid.

[225]Ibid.

[226]Ibid., pp. 146-7.

[227]Ibid., p. 147

[228]Ibid., p. 148

[229]Ibid.

[230]Ibid.

[231]Ibid.

[232]Ibid.

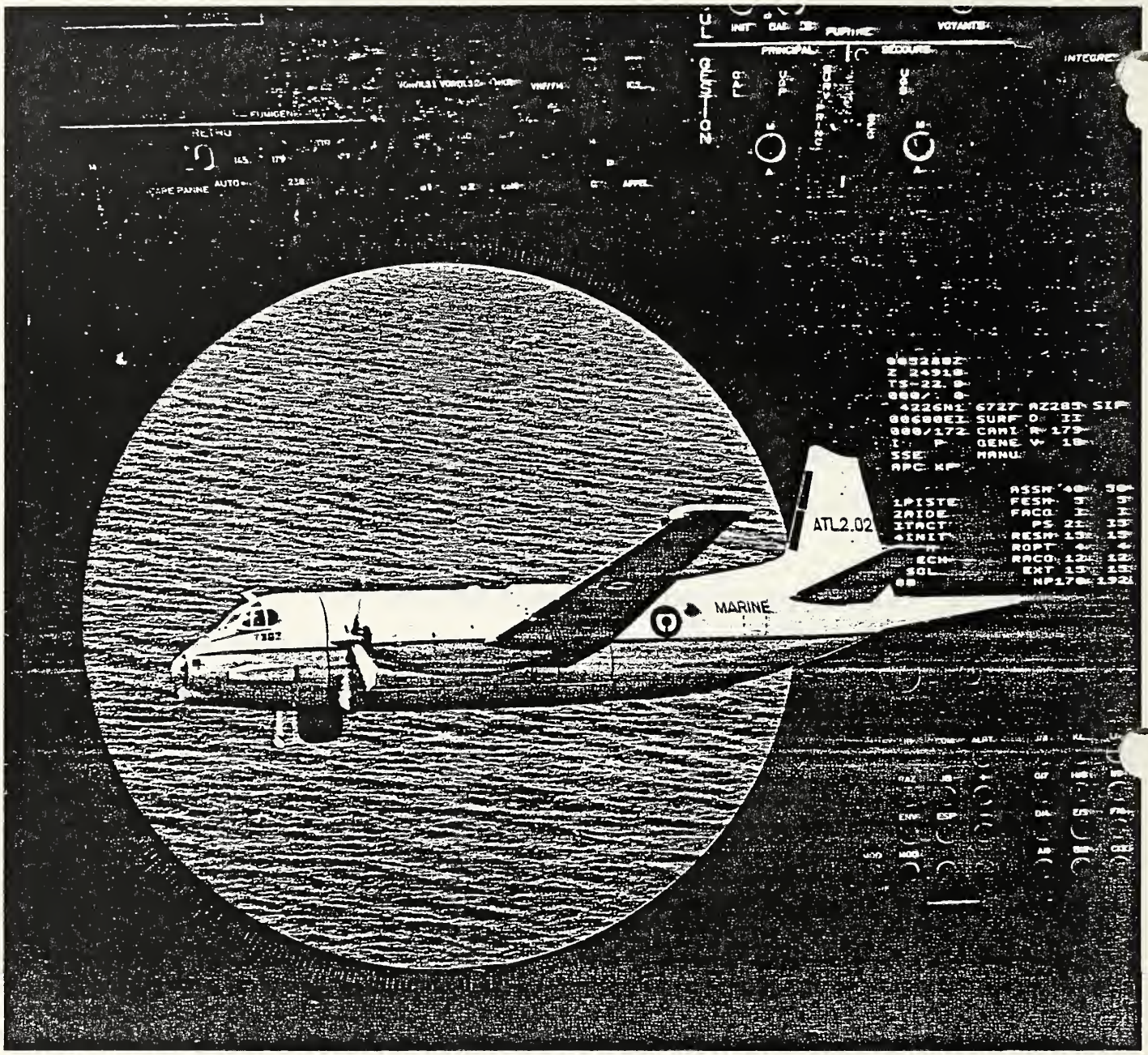
[233]Ibid.
[234]Ibid., pp. 150
[235]Ibid.
[236]Ibid.

Chapter 8

CODEVELOPMENT AND COPRODUCTION AMONG EUROPEAN NATIONS (Mode #3)

Mode #3 is of considerable long-term importance in that it has come to be the principal alternative to unilateral development for France, the FRG, and the U.K.; i.e., Europe's three medium powers. Mode #3 is a natural expansion on Mode #2 in that not only did the firms jointly produce system, but they moved back into the acquisition cycle to jointly design and/or develop them as well.

The first such project was the Atlantic Maritime Patrol Aircraft which originated within a NATO institutional framework, instead of on an ad hoc basis. For purposes of this paper, the Atlantic is best looked at as one of the key institutionally derived NATO projects, even though, in the end, it also turned out to be the forerunner of the ad hoc joint development projects. The next two joint development projects were launched in the late 50's, the Franco-German Transall cargo/transport aircraft and a Franco-German tank program. (The Atlantic, as well, it turned out was basically a Franco-German project.) The cargo/transport aircraft program led to production of the Transall, while the tank program split off into two separate ones. A fourth joint development project was launched in 1964, the Anglo-French Martel AS missile. With this project, the British as well began to utilize this Mode. Though the Atlantic represented an integrated joint management effort (be it French dominated), the latter three were more loosely coordinated efforts where the participating industries operated within their own national procurement systems.



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In 1965, joint development projects mushroomed, the U.K. having finally abandoned its policy of unilateral development on an across the board basis. Three more Franco- German development projects involving tactical missiles were launched in 1965, and between 1965 and 1967 five Anglo French projects were launched, four of which survived. The British half of the one that didn't, joined the Germans and Italians in the MRCA project in 1968.

All of the European joint development projects launched in this 1965-67 time frame (i.e. between the Martel and MRCA projects) were also part of package deals (Mode #8). Mode #8 is a closely related offshoot of Mode #3 and is treated in a separate chapter. These were somewhat along the lines of the DOD's current "family of weapons" concept except that there was less of a cross project trade off within these earlier packages.

After an intermediate stage in multi-national procurement systems represented by the Jaguar program (i.e., a jointly owned shell company registered in France contracting with the French government for the airframe and avionics and subcontracting to its two coequal shareholders, with a parallel system in the U.K. for the engines) there currently appears to be four types of systems in use in the late 70's for Mode #3 and Mode #8 projects. One involves the permanent binational office and its counterpart Groupement d'Interet Economique covering three Franco-German tactical missile projects. Two, there is the system by which the Anglo-French Projects Group oversee Project Management Committees for each of the three joint helicopter development programs. One nation's government handles the procurement for both governments for any given project with the given government's industry also acting as the prime. Three,

the Alplajet represents a continuation of a system similar to that followed for the Atlantic in which development takes place under the supervision of a multinational project steering committee, but through one nation's procurement system with the firm representing this lead nation acting as prime (unlike the Anglo-French helicopter case though, there is no trade off within a multi-project package). And finally, there is an approach wherein an international system unique to that project is set up with an international project office (NPLO) procuring the system from either an international company or again from an industrial team wherein one nation's lead firm acts as prime. This was more or less the system used for the first wave of Mode #2 projects (i.e. Hawk and F-104G). This system is the one being used for those Mode #3 projects involving more than two nations wherein at least two of the participants are also medium powers. This has included the MRCA Tornado and ASSM.

U.S. firms are not excluded from this mix of French-German-British programs, but are involved as subcontractors, licensors of subsystems, or licensees of the total systems.

A. Two Franco-German Tank Projects

It is fitting to start this chapter with the second European joint development program, one which had the distinction of being the first such program to collapse. With the Franco-German tank programs we go full cycle from this early failure, back to a second try by the same two partners some 22 years later.

1. The First Franco-German Tank Project (1957 - 1963)

But first one must back up to the first joint development program, the Atlantic, a project history that was treated in Chapter 5. The Atlantic Maritime Patrol Aircraft, as the choice of its name might indicate, represented an important milestone in the evolution of NATO collaboration away from an attempt at a directed alliance-wide approach to one involving collaboration on a given system by an ad hoc grouping of interested nations. The Atlantic was a project which benefited from two temporary supports. The first of which involved the almost total dependence of the German aerospace industry on foreign systems. The second was the U.S. willingness to heavily subsidize the launching of such programs through the Military Assistance Program (MAP) so as to help the Europeans move toward greater self sufficiency. The Franco-German tank project was not to benefit from either of these.

The details of collaboration for the first Franco-German tank program were never fully elaborated. Shortly after it started, and the program began to veer off in two directions, was patched up, and finally, after a total of five years, split off into two projects once and for all; the French AMX-30 and the German Leopard I.

With the launching of the second Franco-German tank program in February 1980, two major differences are readily apparent. One, a great deal has since been learned in the art of managing such projects, an advancement in an area of management know-how from which this second attempt will undoubtedly benefit. Secondly, there is greater interest this time around on both the part of the two continental medium powers and the smaller European industrial nations for a wider participation in design and development.

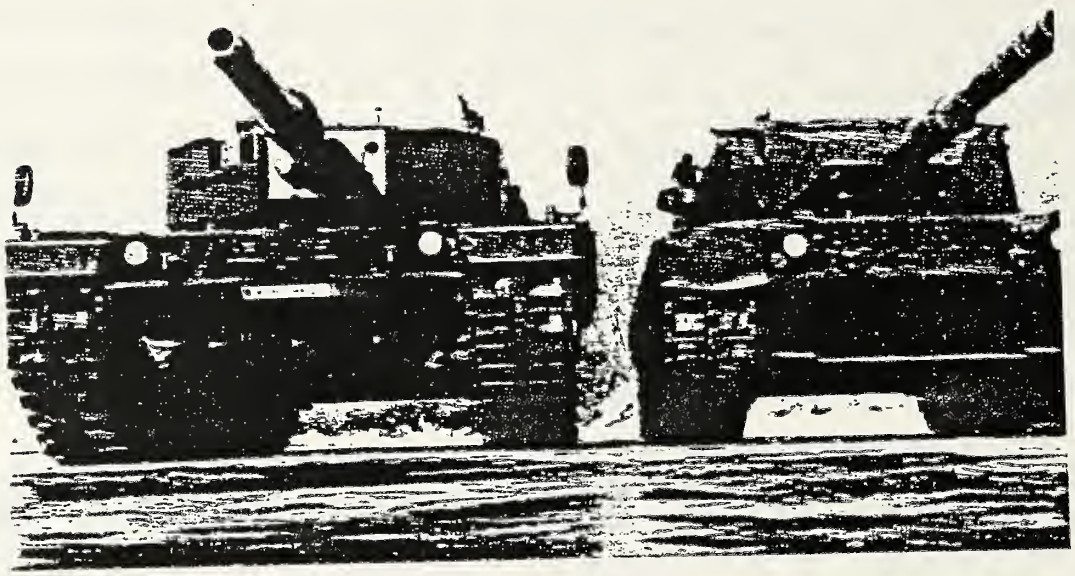
In 1958 the FRG had begun its first major postwar development project, a tank, an area where her capabilities and experience had previously proved to be particularly outstanding. The French, who were short of funds but eager to start their own postwar tank development effort, suggested that the two initiate a joint development effort. The Germans accepted and work began on the joint program the same year. Italy also agreed to participate but soon dropped out for financial reasons.

By the mid-50's the allies had recognized the need to replace several thousand obsolete tanks in Western Europe. The military authorities, however, were unable to agree on a single set of operational characteristics. At this point in time there was little serious interest in joint development on the part of the two Anglo-Saxon powers, be it a tank or any other system. As for tanks in particular, whereas the French and German armies had very similar philosophies with regards to tank warfare, preferring lighter, more maneuverable tanks, the British and Americans did not share their concept. The Americans, and especially the British, placed greater priority on fire power as well as armored protection. These differences naturally led to the design of radically different

tanks, with the British concept being eventually embodied in the Chieftain tank, one developed in the same time frame as the French and German systems.[1] As for the U.S., it had already gone ahead unilaterally. Its requirement was to be satisfied by the M-60 tank, which was to enter production the following year, 1959.

Initially the Germans were to develop the turret using the British 105 mm L7 gun[2], and the French were to develop the chassis. The agreement being a loose one, the two national efforts proceeded more or less independently in each country. France soon began developing a turret and a 105 mm gun, and the FRG a chassis as backup alternatives to the other half of the system.[3] Each country was convinced it had a superior overall design—there being no binding agreement on design control or selection. As an attempt to salvage the joint program, it was agreed that both turrets and chassis would be interchangeable, and that when the developmental efforts were completed, in the 1962-63 time frame, one or the other would be selected for common production. An international committee headed up by an Italian general would be the judge.[4]

When the deadline for the competitive prototype selection finally arrived in 1963, the FRG let it be known several weeks prior to the evaluation, that whatever the results of the contest, it would have to proceed unilaterally with the production of its own system, the Leopard I. The stunned French replied in kind. The Germans stated that the French tank, the AMX-30,[5] was not far enough along in development to go into production soon, and that, since they needed to go into production immediately, they could not afford to wait the extra year or two.[6] Following the competitive selection failures represented



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by the NATO LWSR fighter (1957) and NBMR 3 (1962) this aborted tank competition put such common competitive selections (wherein the selecting nations also had industrial contestants) to rest once and for all.

As maudlin as it might seem in hindsight, Vandevanter at the time portrayed the Dutch and Belgians as unfortunate victims of the aborted common selection.

> Caught in the middle of this development were the Dutch and the Belgians, who between them had planned to buy about one thousand of the winning vehicles to replace their aging Centurions and Pattons. The Low Countries have had to set up their own joint military investigating committee to advise on which tank to buy. Both Dutch and Belgian political authorities expect strong opposition in their parliaments to whatever decision is made.[7]

As it turned out, the increased competitiveness redounded to their individual advantage. In the protracted competition that followed, the Netherlands was able to extract guarantees of internal and external offsets from the Germans for some 90% of the value of their Leopard I buy. The Belgians, for their part, received a 100% offset for their Leopard I's.[8] There was some truth in any case in Vandevanter's allusion to the unfavorable political and diplomatic repercussions that can result from such competitions. On the diplomatic level, the Americans entered the competition with an aggressive campaign to sell the M-60 to the Belgians and Dutch. According to reports in the Belgian press, the U.S. Ambassador, Mr. Douglas MacArthur, Jr., informed Belgian authorities at the time that an order for the French tank would be interpreted as a "very unfriendly" gesture.

The Leopard I as it turned out eventually became virtually the standard NATO tank, being adopted by the Netherlands, Belgium, Norway, Denmark, Italy, and

Canada as well. The first three of these nations' procurements were directly off the German production line involving mixes of internal and external offsets and are treated in Chapter 11 (Mode #6). The Italians on the other hand, though being early drop outs of the Franco-German program, eventually procurred the Leopard I through production under license in Italy (Mode #1). Greece was the only other NATO member to procure the other half of the 'joint' program, the French AMX-30. The Greek purchase was also accompanied by offset work to Greek industry. No NATO members beside the British themselves ever procurred the Chieftain.

To realize what this reemergence of continental European industrial and technical capabilities during the 1960's has meant for NATO standardization, one has only to contrast the dominant tank of the 1950's with that of the 1970's. During the 50's the American M-48 practically became NATO's standard tank and is still in wide-scale service with NATO armies (production has long since ended). By the 1970's the Leopard I had assumed the position of the dominant NATO tank, over 4,500 having been built for 7 countries. The only other NATO army to procure the U.S. Army's M-60 was Italy, but the tank was not popular and the country soon switched to Leopard I.

2. The Second Franco-German Tank Project (1980-1981)

In early 1980 France and the FRG's decided to make another go of it. After the FRG's unsuccessful joint program with the U.S. from 1963-1970, the MBT-70 (see Chapter 10), and an unsuccessful try with their third major ally, the British, the FMBT[9] in the mid-70's, the two original partners joined up once again in 1980 with their respective Defense Ministers (Yvon Bourges and Hans

Apel) signing an agreement in principle on February 5. The agreement covered the joint definition and development of a new main battle tank to replace the AMX-30 and Leopard II.[10] The tank was to be equipped with a 120 mm cannon, have a weight of 50 to 60 tons and include a number of inhancements such as a night firing capability.

A market of 2,500 tanks for each country was foreseen, the principal industrial participation being by the Delegation Generale a l'Armament's[11] Groupement Industriel des Armaments Terrestres (GIAT) in France and MKS (MaK-Krauss-Maffei-Sondertechnik) in FRG. These were the same two in the earlier program as well. A number of prototypes were to be built with the design to be frozen by 1983.

This time around France and the FRG are also attempting to widen the grouping of participants.

Prior to the announcement of the agreement to develop a new tank, Belgian industry had been invited to participate. GIAT, the French prime contractor, had initially proposed Belgian participation during negotiations for new Belgian armored vehicles, however, Belgium apparently reacted indifferently to the proposal, before selecting U.S. armored vehicles; the M113 and the AIFV (see footnote on page 10 of Chapter 6). But in light of the Franco-German announcement, Belgium was expected to reconsider. Such a tank would obviously be a prime contender for the Force Terrestre's Leopard 1 replacement in the 1990s.[12]

In mid-March 1980, the Dutch secretary of state for defense, M. Wm Van Edkelen, announced his government's interest in participating in the Franco-German program

to develop a new main battle tank. The Netherlands would require between 400-450 tanks during the late 1990s and was reportedly seeking a share of the program valued at about 10 percent.[13]

The February 1980 agreement spelled out the intergovernmental and interindustrial organization of the program. A Policy Committee (Comite Directeur) would oversee the program from Paris and a program office located in Hamburg would coordinate the work of the industrial team. Both governmental bodies would be composed of equal numbers of Germans and French. In his address on the 1981 military equipment budget and the allotment of work that would go to the state owned arsenals, made to the leadership of the unions representing French civilian defense personnel on November 6, 1980, France's Minister of Defense, Joel Le Theule, attempted to placate concerns over whether France would be collaborating as a fully equal partner. As quoted in Le Monde, he addressed these concerns by giving the following description of the distribution of tasks within the joint project:

> "The development of the new tank will be carried out in common, in relying principally on French and West German technology. Work will be divided between the two countries so as to assure the maintenance of both a qualitative and quantitative balance, in particular the principal sub-systems will be developed by teams each consisting of one firm from each nation. The joint technical efforts will be covered by agreements guaranteeing the rights and interests of each while preserving their technological independence. Each country will have a production line on its own territory, as though the hardware had been developed on a purely national basis. Each country will be authorized to export on the basis of arrangements analogous to those which govern other cooperative programs involving the two nations."[14]

In order to reaffirm that France was entering into these negotiations from a position of strength, Le Theule concluded:

> "France is currently fully capable of entering into development of this tank on its own and therefore presents herself as a major partner for collaborating on this project. She possesses the necessary technological capabilities which will allow her to assert her interests and preserve, in the face of any eventual outcome her national independence."[15]

The undercurrent of criticism against which this clarification of the nature of French participation was aimed was not unusual for a project of this import even in a country such as France with its extensive history collaborative ties. Several times earlier that fall, the unions representing the civilian employees of the state arsenals and the Delegue Generale a l'Armament, the concerned industrialists, and deputies representing the opposition in the Assemblee Nationale's defense commission such as socialist Charles Hernu, (who was to assume the post of Defense Minister the following spring) expressed their fears of seeing the French government consent, under one form or another, to an abandoning of sovereignty to the benefit of its German partner.[16]

The principal fear of the industrialists was that French government, in order to obtain tradeoffs in other parts of the system, would resign itself to defending only minimally its position in the area of engines, transmissions and cooling systems associated with the diesel power unit chosen for the tank. In competition with proposals of the German firm MTU, there was a French project for a 1500 horse power diesel engine utilizing 'hyperbarisation' (conceived by the French firm SSCM), which involves a high rate of fuel injection that would quintruple the number of horse power per cylinder[17].

Without prejudicing the outcome of negotiations underway at this time, France's Delegue Generale a l'Armament, Jean Matre, indicated to the deputies that the

discussions were not attempting to define, i.e. select, the motor. France, however, was making it known that they too had a diesel project of their own with sufficient power but with 20 to 30 percent less weight than that of MTU.[18]

Some four months later, on March 7, 1981, the German Defense Minister Hans Apel dropped the bombshell. After some 13 months of intensive studies and negotiations Apel announced that due to budgetary problems, the FRG could no longer entertain the possibility of developing a completely new tank; i.e. the FRG would continue instead with the development of its own Leopard family of tanks. Apel washed his hands of the affair in indicating that if the Chancellor and French President nevertheless still wanted to go forward, they would have to find the necessary funding elsewhere. In the same announcement, following the three day Political-Military conference in which Apel and the heads of the German armed forces reviewed the military equipment budget, Apel let it be known that the FRG was going to drastically cut back on another Franco-German program, the Roland short-range SAM system. Though the Bundeswehr would still receive its 143 fire units, the downstream orders for 175 fire units for the Luftwaffe and another 25 for the Bundesmarine were to be cancelled.[19]

In addition to the seriousness of the overall federal budgetary problems, several culprits were specifically mentioned as draining funds from the two Franco-German projects. The first was the continuing sharp increase in the joint German-British-Italian Tornado fighter and the second was the on-going need to subsidize with public funds the German industrial participants in another joint project in the French were its principal partners, Airbus Industrie.[20] There was also mention of pressure on the Bonn government from

the U.S. to increase its share of the costs of stationing U.S. troops in the FRG.[21]

On the technical side a divergence of views existed at two levels. Where exactly were the two armies trying to get to, i.e. aligning their ultimate goals in one common definition of a tank for the 1990's. Though there were still some problems in this area involving both technical requirements and the prevailing tactical concepts, these were not insurmountable.[22] The real problem lay at the lower level, the line of departure, i.e., where were they starting from? The French Army was still operating with the AMX-30 and would be for the rest of the decade. The AMX-30 was of the same vintage as the German Leopard I, the other half of their aborted joint tank project of the late 50's and early 60's. In the meantime the FRG had drastically upgraded its tank in the form of the Leopard II, a very sophisticated tank entering service in 1980. As we'll see in Chapter 10 the same problem of conflicting replacement schedules occurred with the joint German-American Main Battle Tank for 70's (MBT-70). The FRG's partner in both projects had a much wider gap to fill between generations. The replacement schedule for the German's in each case was far less urgent in comparison, especially the more recent project.

According to France's Armament Director (Delegue Generale a l'Armament), Jean Matre, the operational characteristics driving the requirement for a replacement tank on the French side included the need for:

- a larger capacity magazine with a substantial corresponding increase in weight (from the 36 ton AMX-30 to one in the 50-60 ton range);

- and consequently a doubling of horse power;
- a lower silhouette, automatic training of the turret;
- plus the optional capability of firing while moving.[23]

While the German army had had a major improvement program in the form of the Leopard II, (a tank already weighing in excess of 50 tons) the French had only a limited improvement program resulting in the 40-ton AMX-32. The AMX-32 in any case, was produced for export purposes only, not the equipping of France's own army.

Of the above French requirements the only one among them of major interest to the FRG was that of a lower silhouette. In explaining his decision, the German Defense Minister pointed out that the capabilities of Leopard II were quite satisfactory. All that was required to upgrade the system and keep it a viable one through the end of the century was a modification of the turret that would provide a lower silhouette once an automatic gun loading system had been developed. Moreover, these developments were already underway.[24]

This is what had come to be Christianed the 'small solution' in Bonn. This limited enhancement program was favored by many in the German MOD, the Army, the Bundestag, industry and even in Schmidt's cabinet as a much more practical alternative to the project adopted by Chancellor Helmut Schmidt and President Valery Giscard d'Estaing in the eurphoria of a summet meeting. According to experts recourse to tne automatic loading would permit a reduction in the Leopard II crew from 3 down to 2 men, which in turn would allow for a reduction of the tank's silhouette.

AMX 40

an outstanding French battle tank



DECISIVE FIREPOWER

- 120 mm gun - kinetic dart ammunition (APFSDS)
- Automated fire control system for speed and accuracy

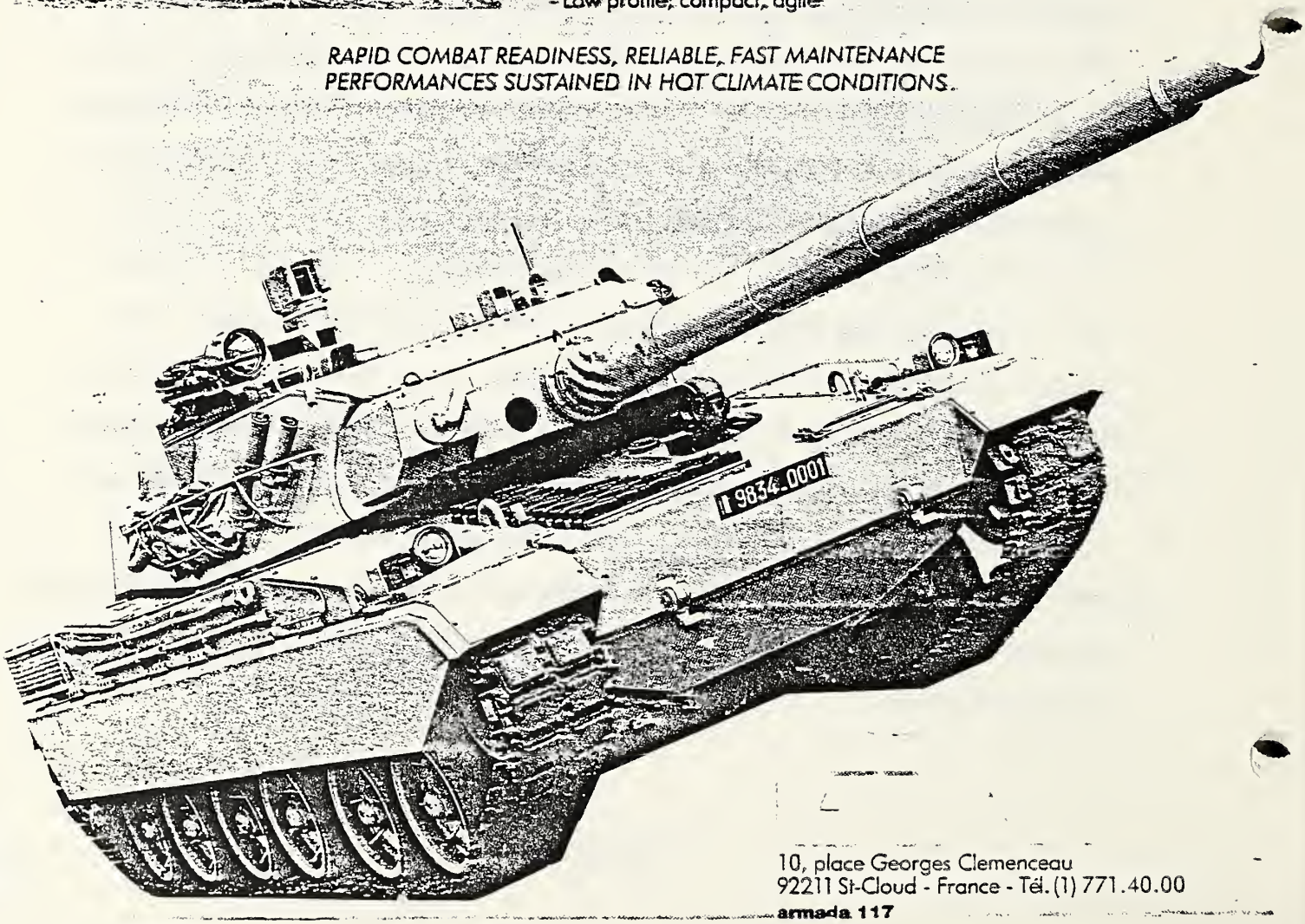
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Also envisaged was the possibility of building a version of the Leopard incorporating, in addition to the above changes, a replacement of the tracks by wheels, one which would result in a substantially lighter tank than the Leopard II. This option was of particular interest in that Bonn has been softening its prior position which excluded the export of defense equipment to non-NATO countries. A lightweight derivative of the Leopard would be much more marketable in those countries lacking the necessary infrastructure for heavy tanks.[25]

Discussions at the technical and financial levels continued between the two nations after Apel's March 7, 1981 announcement. The Germans were proposing to the French that they settle for a role in the development of a new version of the Leopard, a project in which the French share would be very modest to say the least.[26]

With the double announcement of the cancellation of the Franco-German Main Battle Tank for the 90's and the slashing of the German order for the Franco-German Roland by 58%, Le Monde indulged in a bit of the usual journalistic hyperbole:

> "It is the entire development of Franco-German cooperation in the area of conventional armaments that is threatened with disappearance, despite the political will displayed in February 1980 in Paris, at the time of the meeting between Helmut Schmidt and Valery Giscard d'Estaing, which resulted in the signature of a protocol on the joint tank project. A year ago, a certain publicity was given to the conclusion of this agreement because it symbolized at the time the intention of Bonn and Paris to provide a new impetus to a cooperation, dating from some two decades, which had produced tangible results - such as the Transall aircraft, the Alpha Jet and several tactical missiles - in the sensitive area of coproduction of war materiel of all types."[27]

After the meeting of Mr. Apel with his high commandment, it is, on the contrary, disenchantment and doubt which prevail in military and industrial circles in France, while there is a feeling of a certain disillusionment implanting itself in political circles as well..."[28]

B. The Franco-German C-160 Transall

The C-160 Transall (Transporter Allianz) is a cargo/troop transport jointly developed and produced by France and the FRG following a Basic Agreement signed January 28, 1959. The Transall was the second of the successfully codeveloped European systems (actually the third such project but the Franco-German tank project broke-up). The first prototype flew in February 1963 and delivery commenced in 1968 with the Luftwaffe receiving 113, the Armee de l' Air 53, and the Republic of South Africa 9. Twenty of the Luftwaffe's were later handed over to another NATO ally, Turkey, on aid terms. The last of the original 175 Transalls built, was completed in 1972.[29] The Transall project is an outgrowth of an earlier project wherein the same group of firms were involved in the production of the French Noratlas transport which was produced in the FRG under license (Mode #1, Chapter 6).

The Transall was jointly developed and produced by the participating firms in the Arbeitsgemeinschaft[30] Transall consisting of Nord Aviation of France, and Hamburger Flugzeugbau (later the 'Blohm', of MBB) and VFW of the FRG. The airframe's production was split approximately on the basis of the national orders between the two national industries.[31] Within the Arbeitsgemeinschaft Transall, VFW had the position of design leadership and overall manager of the project. The engine for the Transall is the Tyne which was produced under license from Rolls Royce for both the Atlantic ASW patrol aircraft and the Transall, by a consortium of French, German, British and Belgian firms.[32]

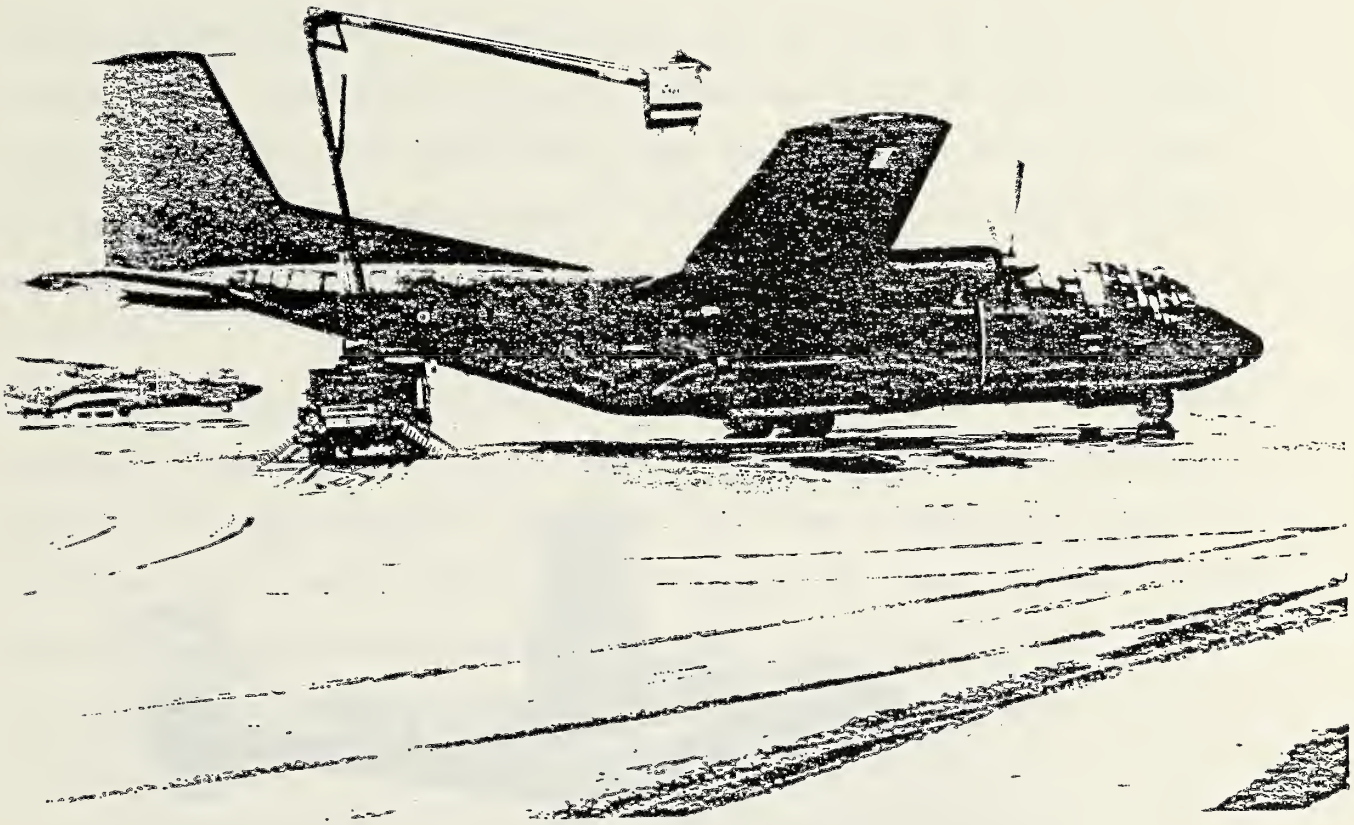


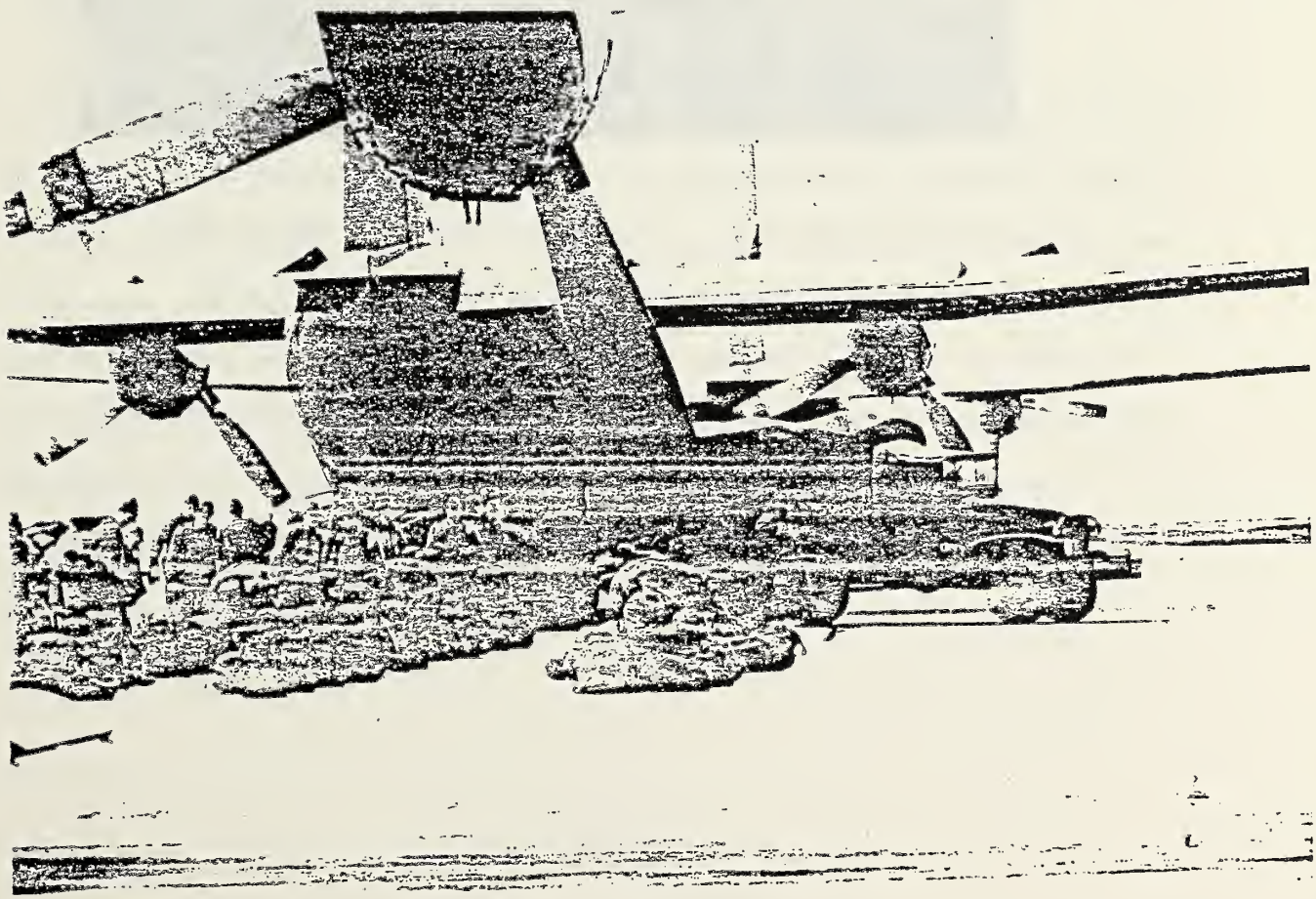






(ECPA)







C-160 Transall Source: NATO's Fifteen Nations

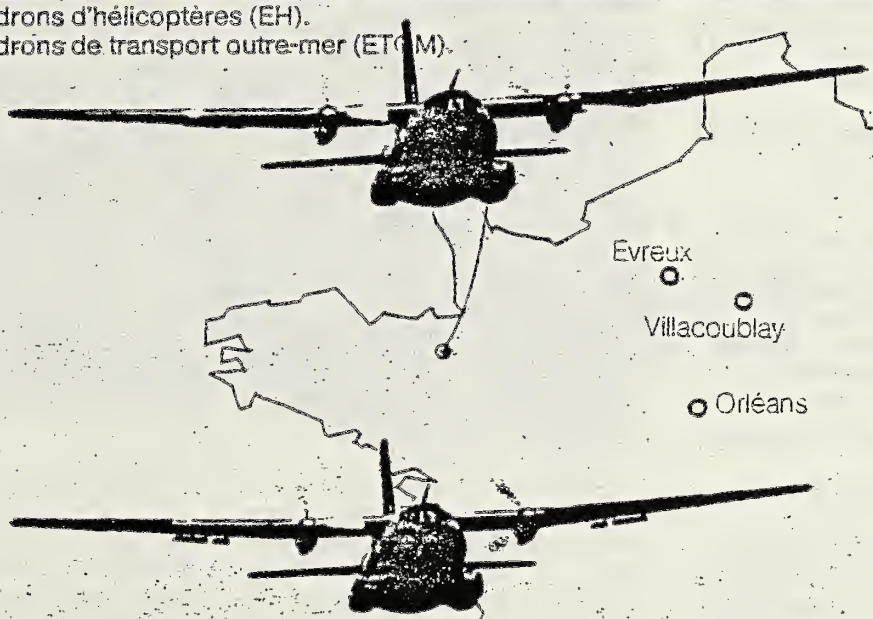
The two governments funded the joint venture by individual contracts to their national firms. Development costs were divided equally by the French and German Governments. Since the project received NATO sponsorship its policy or steering committee became the NATO Transall Steering Committee consisting of French and German representatives and Italian observers.[33]

The Transall project included the usual mixed bag of advantages and disadvantages involved in codevelopment. First, though figured to have cost about 50% more than if it had been unilaterally developed, the plane is 25% cheaper to the individual nations because of it being a joint venture. Second, Italy's initial interest in the project never materialized, nor did the expected export market, but then neither did the German reduction of their orders to 90 aircraft in the late 60's materialize (having been brought back up to 113). So, as often is the case in such projects, a larger order base was maintained despite the instability in the individual national orders, and poor export results.

The difficulties faced during the project were briefly described by Sud-Aviation President Henri Ziegler in mid-1969. First, major difficulties arose from the state of the resurgent German aircraft industry in 1959, when the program was initiated. Second, difficulties also resulted from the different working methods of industry and government in France and the FRG. Third, the choice of equipment was complicated by the need for the work to be divided between the two nations, with the numerous meetings thus leading to a lengthening of delivery periods.

Stationnement des unités navigantes du COTAM

Escadres (Escadrons de transport - ET), Escadrons de transport et d'entraînement (ETE).
Escadrons d'hélicoptères (EH).
Escadrons de transport outre-mer (ETOM).



Métropole

Aix les Milles : ETE "Mistral", EH "Alpilles"
Apt : EH "Durance"
Bordeaux Mérignac : ETE "Médoc"
Cazaux : EH "Pyrénées"
Chambéry : CIEH "Maurienne"
Évreux : 64e Escadre ("Béarn", "Anjou"), Groupe "Vaucluse"
Metz : ETE "Verdun", EH "Valmy"
Orléans : 61e Escadre ("Touraine", "Franche-Comté", "Poitou")
Solenzara : ELAS 1/44
Toulouse : 63e Escadre (CIET, "Vercors")
Villacoublay : 65e Escadre ("Vendôme", "Rambouillet") ET "Estérel", EH "Parisis", GLAM

Outre-mer

Djibouti ETOM 88
Polynésie : "Maine"
Nouméa : "Tontouta"
Dakar : "Ouessant"
Antilles-Guyane : "Guadeloupe"
La Réunion : "La Réunion"

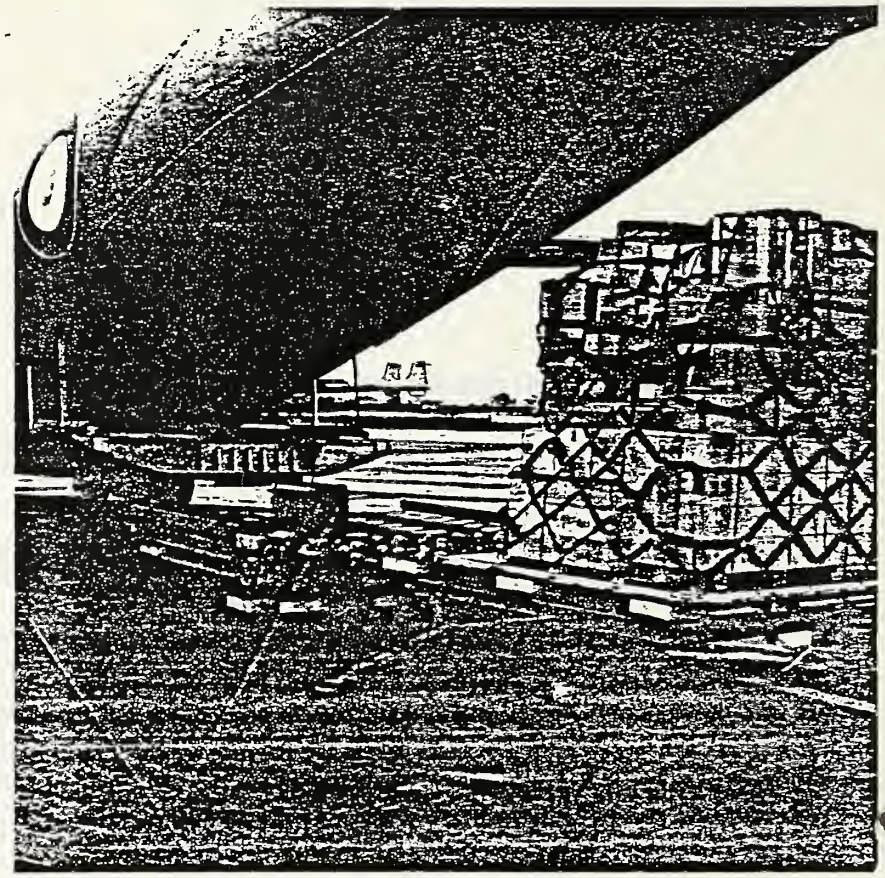
Deux C 160 nouvelle génération de la 64e Escadre de Transport (photo A de Ehrmann).

Capacités

La valeur opérationnelle du TAM peut être appréciée grâce à deux critères principaux qui sont les capacités de transport et d'emport instantané.

La capacité de transport, tonnage pouvant être acheminé sur un itinéraire donné pendant un temps donné, s'exprime en tonnes-kilomètres ou passagers-kilomètres par jour. Elle est fonction :
- des aéronefs et leurs caractéristiques,
- des facilités de mise en œuvre aux escales (chargement, déchargement, ravitaillement),
- des impératifs inhérents à la maintenance,
- du nombre d'étapes et de leur durée, et, par le fait, du nombre d'équipages disponibles.

La capacité d'emport instantané représente le total des charges pouvant être enlevées à un moment donné et pour une destination déterminée par les aéronefs disponibles. Exprimée en tonnes, elle est un critère essentiel d'efficacité d'une flotte militaire.



Palette en cours de chargement a Orléans (photo BCRE).

dernières étant principalement des aéroportages ou aérolargages.

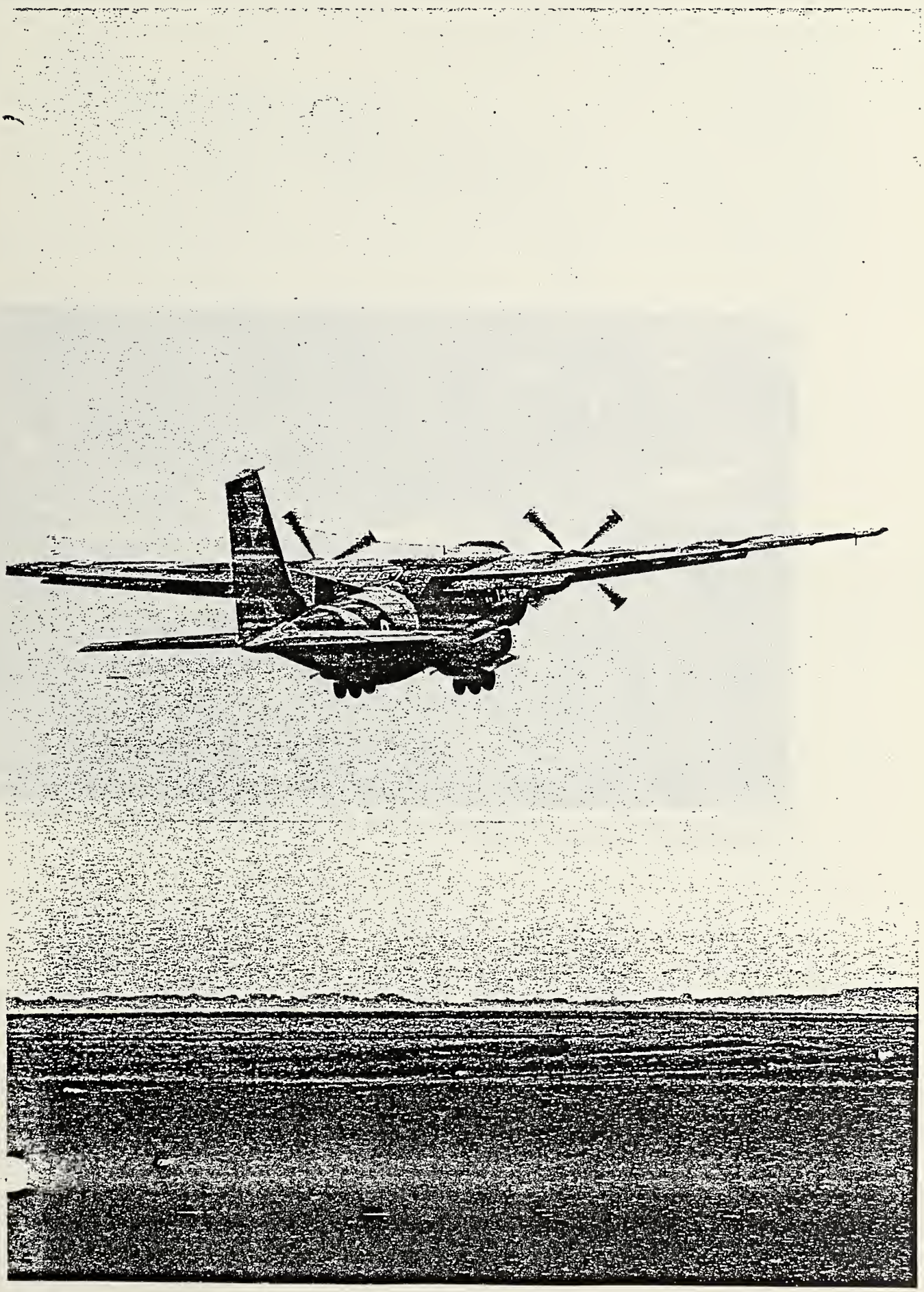
Dès le temps de paix, l'**assistance rapide** peut conduire le Transport aérien militaire à exécuter des missions destinées à renforcer, ou favoriser l'application de la politique d'aide à des pays amis.

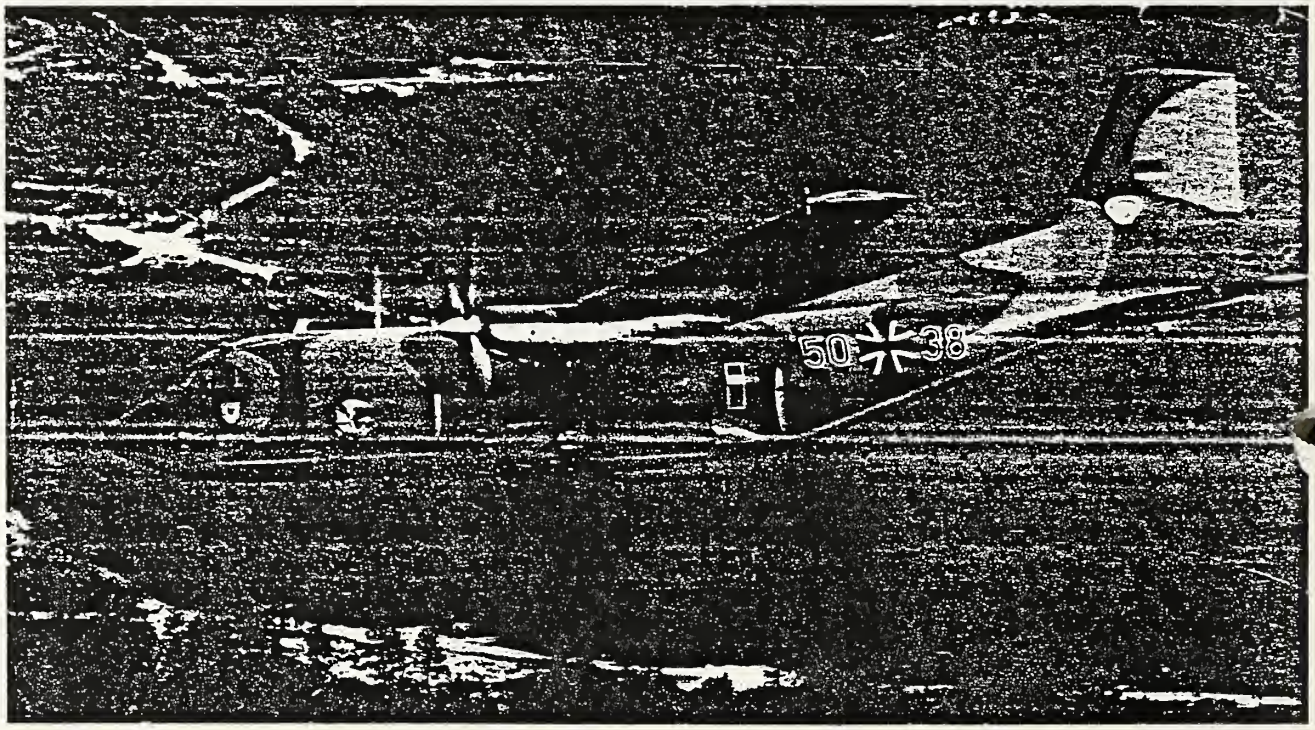
L'aptitude professionnelle est attestée par l'attribution à tout membre d'équipage d'une double **qualification** "ligne" et tactique, confirmée par l'exécution de très nombreuses missions d'assistance rapide ou à caractère humanitaire, loin de la métropole, dans des conditions d'infrastructure difficiles, voire inexistantes.

Enfin, il peut être amené à mettre sur pied des **transports de remplacement** et acheminer des moyens de renfort pour assurer, en cas de crise grave, le bon fonctionnement de certains services publics indispensables à la vie de la Nation.



Exercice de parachutage massif a Pau (photo BCRE).





Aerial view of a German Air Force C-160 Transall. The German Air Force's Transport Command has four squadrons equipped with seventy-five of these aircraft.



Photos du mois

Deux photos prises au Tchad illustrant la variété des missions du COTAM et par la-même, celles de "Armée de l'air.
Deux Transall NG ravitaillent en carburant trois Puma de l'Armée de terre, et un C160 NG également vient de décharger des vivres dans le cadre de l'aide humanitaire apportée par la France.
(photos Armée de l'air).



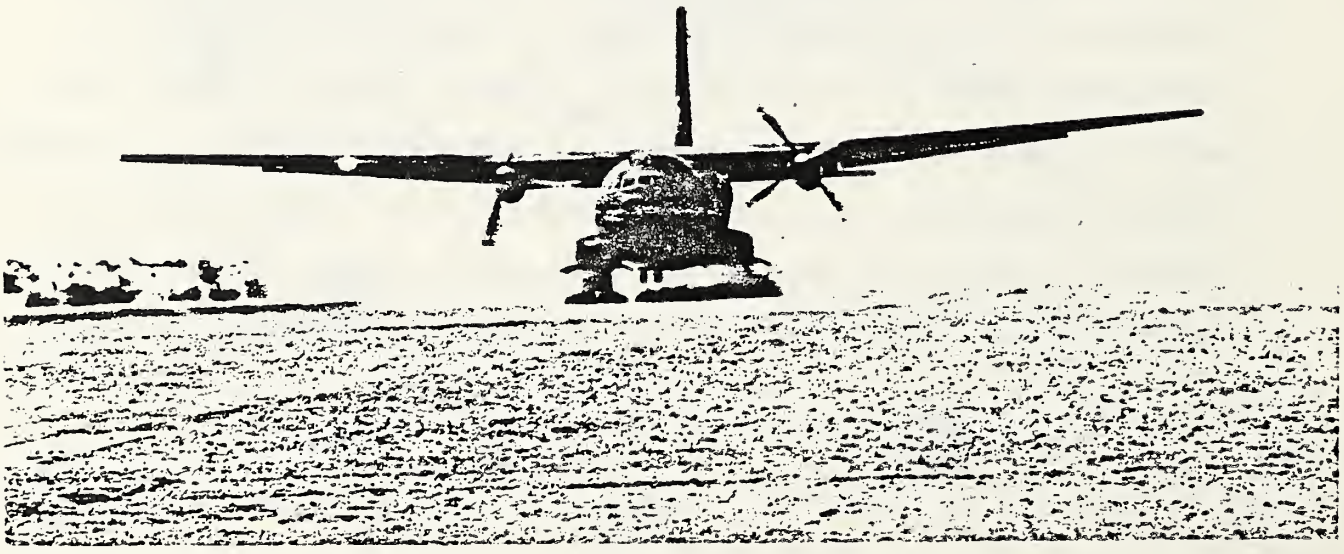


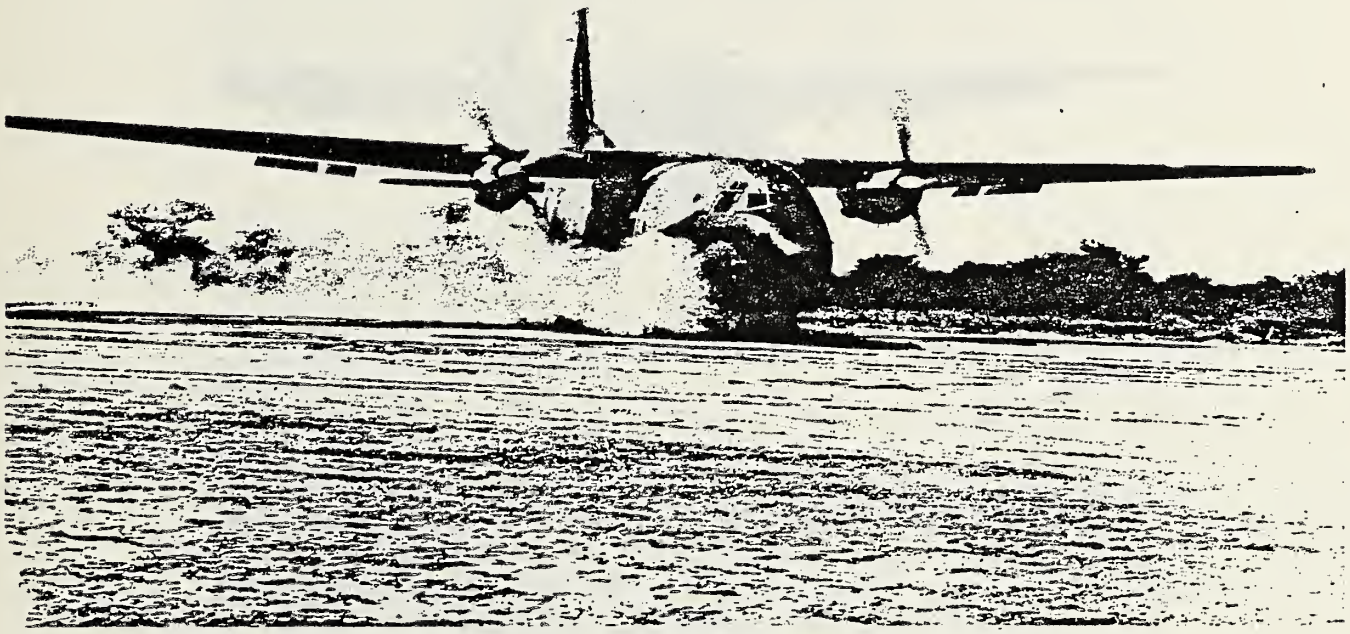
Fourth, important lessons learned from this early joint development project, are that a single design leader should be named during the various stages, and that transferring the manufacture of a component from one firm to another is costly and should be avoided.[34]

Finally, critics of the consortium concept emphasize another major drawback of such projects well exemplified by the Transall. The Transall is the result of a compromise between the French requirements for a long-haul transport and the German requirements for a short-range transport with STOL capabilities—a compromise involving some rather problematic trade-offs.[35]

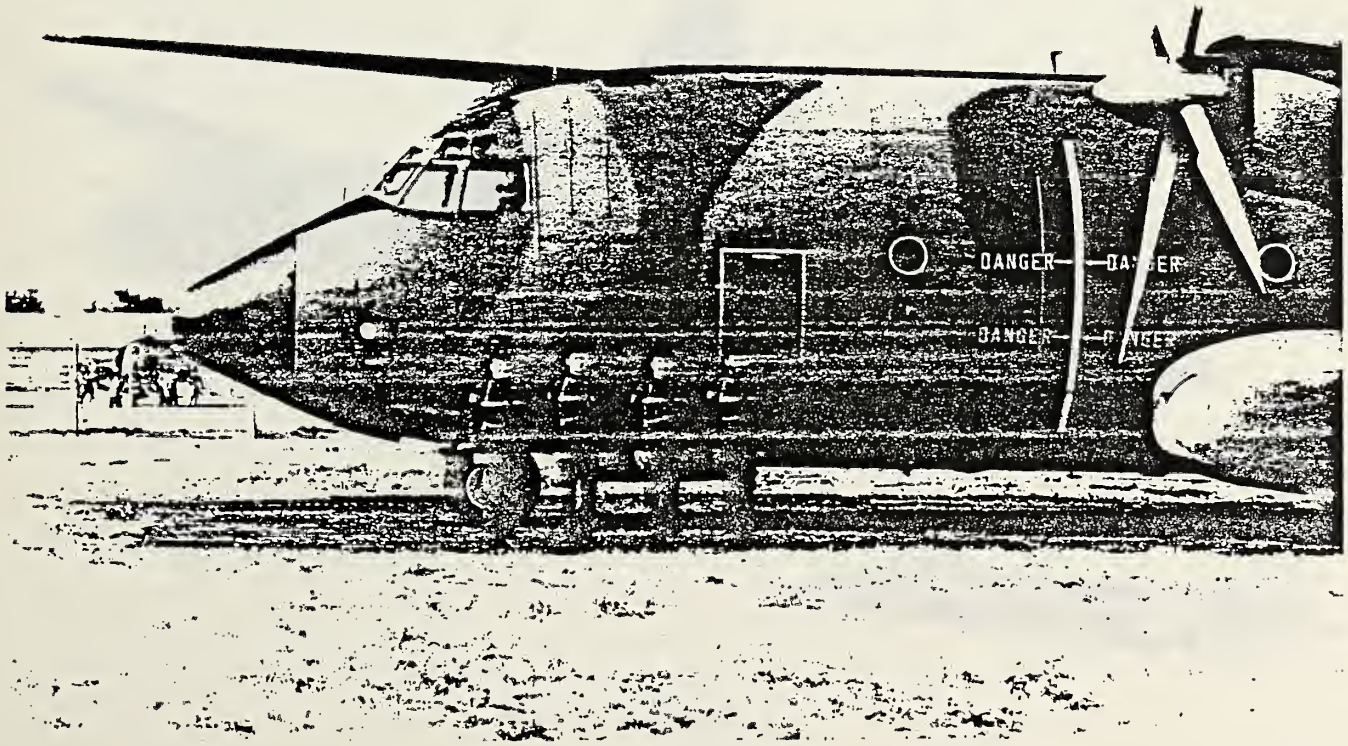
In 1976 Aerospatiale, MBB, and VFW-Fokker signed a letter of intent covering the restart of the production of the Transall. Despite the original plan to obtain some 75 new orders so as to justify the relaunching of production, i.e. 75 aircraft marking the break even point, the French Government announced in mid-1977 that the Transall line would be reopened on the basis of the Armee de l' Air's order of only 25 additional aircraft. Aerospatiale is the project manager for this second production run, and the lack of other orders suggests that the production restart will have to be heavily subsidized by the French Government. The only foreign sale reported so far was for three C-160's for Indonesian government. Though the Germans lost project leadership for this second phase, German firms will naturally also get a substantial share of the work. The new aircraft will be equipped with additional fuel tanks and in-flight refueling capability so as to extend the Armee de l' Air's long-range airlift capability. Despite the lack of a true long-range heavy-lift aircraft (the result of the compromise with the FRG), the French Government reportedly had

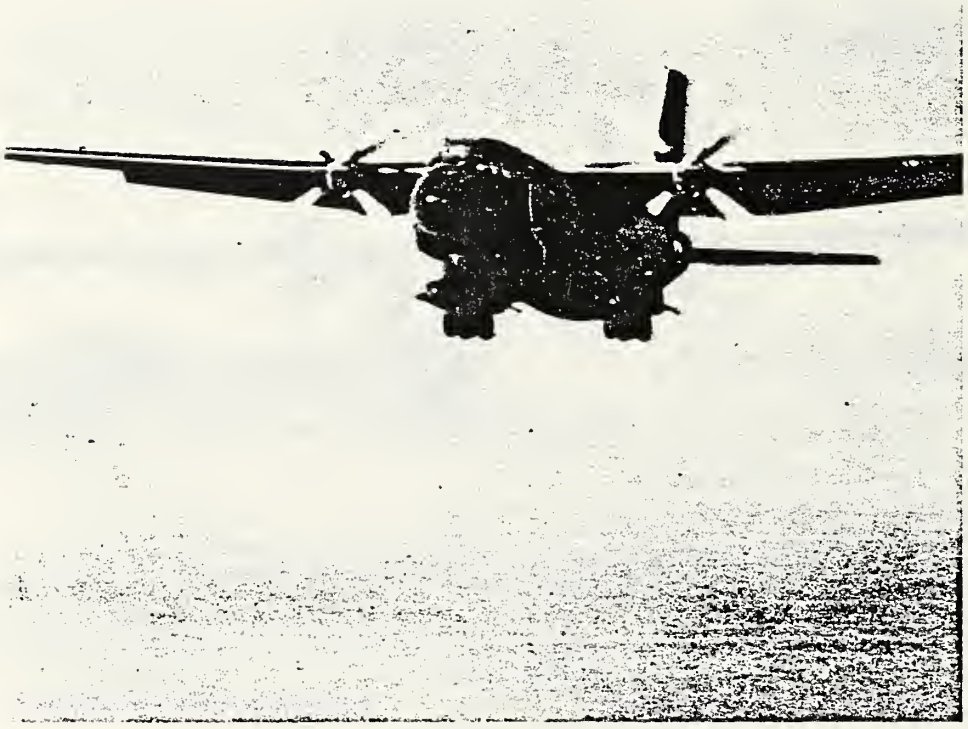






Atterrissage sur piste sommaire lors d'une action extérieure (photo Adc Tixier).





The TRANSALL is a joint franco-german development. A new series of thirty of these machines could replace the aging NORD 2501, known as the Noratlas.





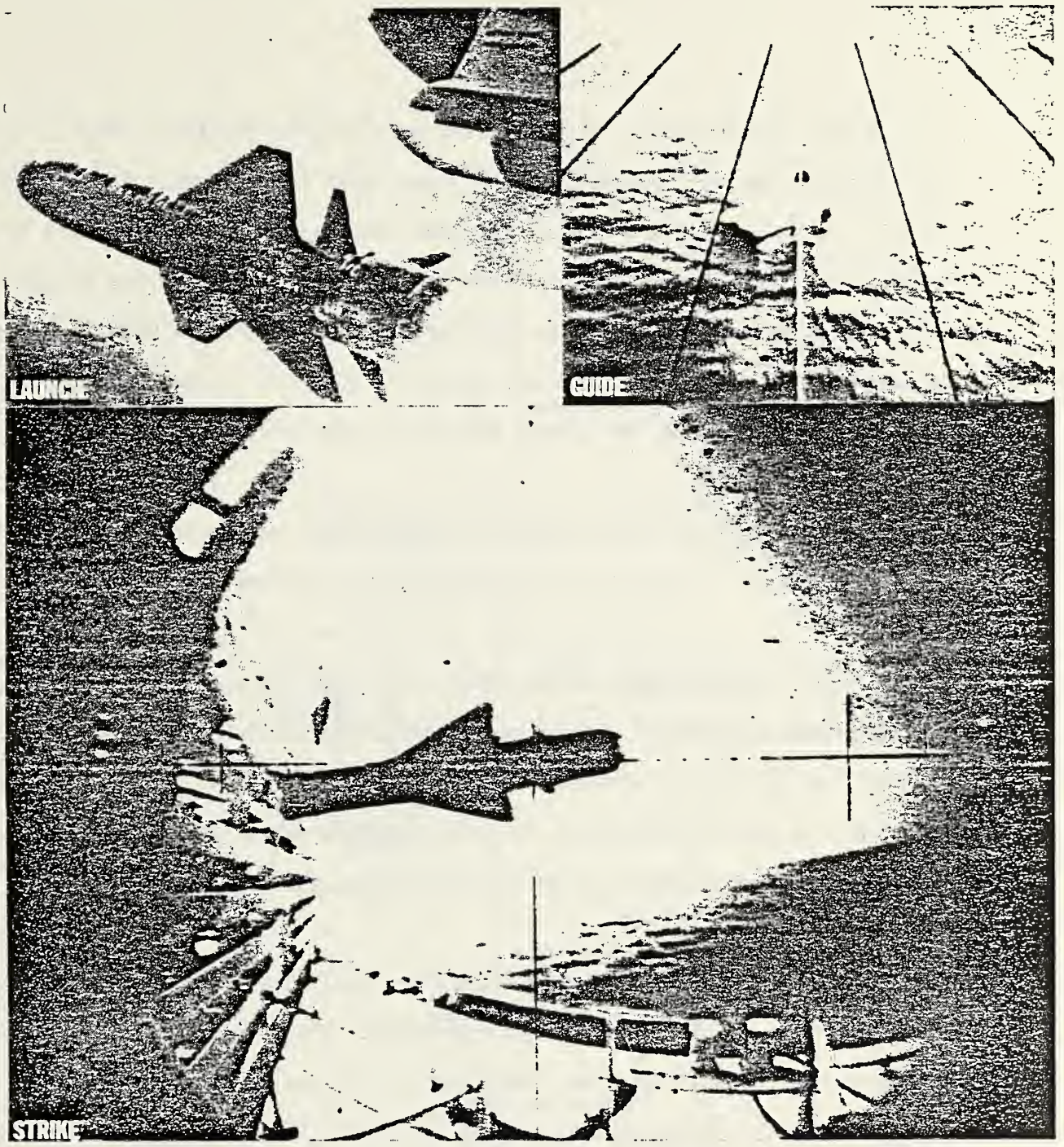
no intention of looking outside France, at the Lockheed C-130 or any other aircraft to fulfill the requirement.[36] Once again, considerations of a domestic procurement prevailed in the satisfying of a military requirement.

C. The Anglo-French Martel

The Martel was the fourth intra-European collaborative development project and the first of the Anglo-French development projects. The three preceeding joint development projects had been basically Franco-German (Atlantic, Transall and the Leopard I/AMX-30). On the transatlantic level it was preceeded only by the MBT-70, launched the previous year. The launching of the US-FRG AVS fighter project followed the Martel by several months.

The Martel air-to-ground missile represents a melding of requirements to the French Navy, the Armee de l 'Air and the RAF based on agreements negotiated through mid-1964. In September 1964, Britian's Hawker Siddeley Dynamics and France's Engins Matra signed a joint development agreement. Development reportedly cost $300 million. As always in weapons collaboration, though the requirements were similar, they were not identical; two versions were developed.[37]

The French armed forces required an anti-radiation missile. In addition to Engins Matra, the other French firms participating included Thomson-Brandt, Aerospatiale, and Electronique Marcel Dassault. The later firm was involved in the developing of the guidance system in the anti-radar homing head. With this anti-radar version of the Martel (AS-37), the missile is launched and forgotten. If the target is using its radar, the missile will home onto it. Although the French version is effective in poor visibility and at night, it is totally dependent on the target using its radar.



Martel, on target, on order.

It's the first stand-off missile to give pinpoint accuracy so it has gone into production for the United Kingdom Services.

There are two versions of Martel —jointly developed by Hawker Siddeley Dynamics Limited together with the Marconi Company Limited of the United Kingdom, and S.A. Engins Matra of France.

In one version (Hawker Siddeley and Marconi) a T.V. camera mounted in the nose transmits a picture. Using a joy stick many miles away in the launching aircraft, the weapons operator steers Martel on to the target. In this way 10 ft. diameter targets have been hit from miles away.

The second version (Engins Matra) with an anti-radar homing head operating in the presence of multiple targets will home on the transmission of enemy radar. It also has all-weather capability.

Hawker Siddeley Dynamics
Manor Rd., Hatfield, Hants., England

S.A. Engins Matra
78 Velizy Villacoublay, France

Marconi Ltd.
Basildon, Essex, England

The British on the other hand preferred a television guidance system. This guidance system was developed by the other major British participant GEC/Marconi. In this TV guided version (AJ-168), the missile has a TV camera in the nose which sends back pictures of the ground - and eventually the target - to the launching aircraft where an operator manually steers the missile by radio commands. As opposed to the French version, this one is not dependent on the target's use of radar, but cannot be used in poor visibility or at night.[38]

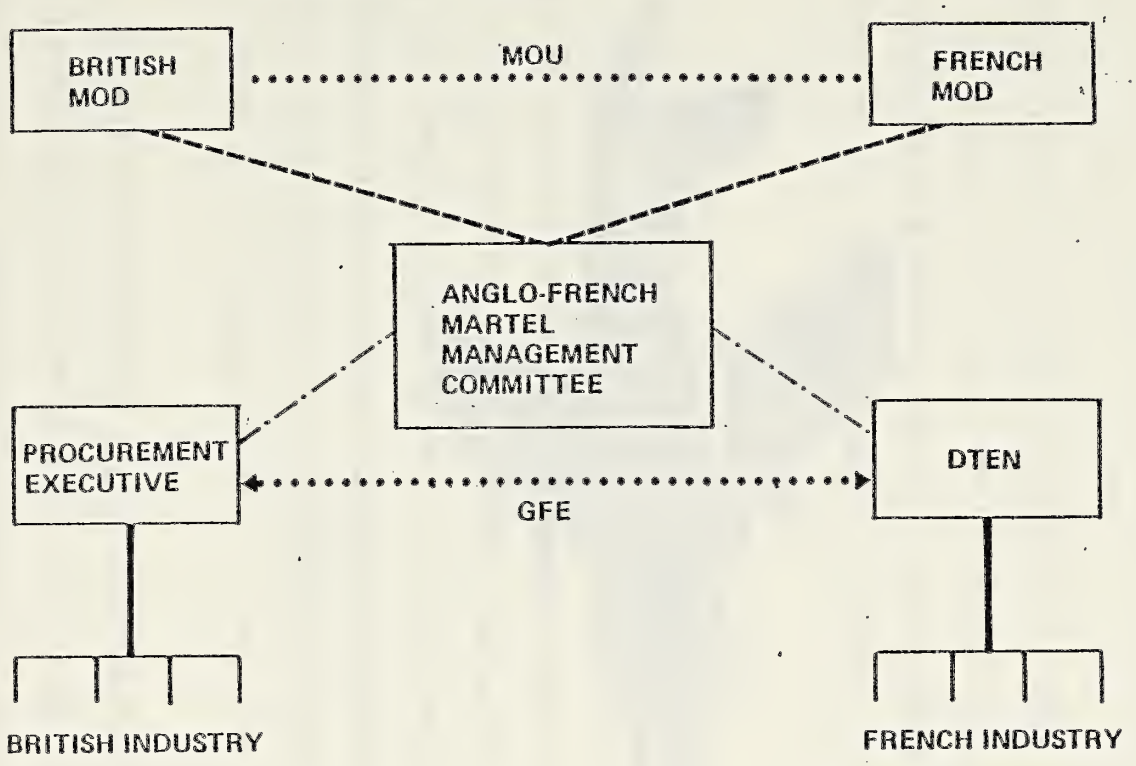
As is common in such joint projects although there was a certain degree of de-standardization, at least the two versions are complementary.

The project is supervised as the other Anglo-French projects - by an Anglo-French Martel Management Committee, within the overall Anglo-French Projects Group. As of 1968 the Management Committee met quarterly and was headed alternatively by French and British directors. There was also a technical subcommittee with specialized working groups that met monthly.

As one of the earlier joint development projects, the collaborative management system chosen by the governments was somewhat primitive. The French and British governments chose to use their two existing national procurement systems to control the collaborative development and production of the Martel, and therefore it was not possible to appoint one prime contractor for the total project.

The 1964 protocol covering codevelopment gives Engins Matra and Hawker Siddeley Dynamics a free license for any component designed by the other. In the case of export sales ever materializing, production is to be divided in half no

Anglo-French Martel
Air-to-Surface Missile



Legend:

- Policy
- Representation, coordination, and administrative support
- Contracting and project management
- Other

matter which version is ordered. Each firm assembles those missiles ordered by its own armed forces. Although the airframe as well is produced in both countries there is minimal duplication elsewhere - both nation's industries producing the components for each others versions.

The Martel has a range of about 60 kilometers. As of 1976 the French were intending to use the missile in their Mirage III's, Jaguars, and Atlantics, while the British were to use it in their Bucaneers MS II and ASW Nimrods. As of the fall of 1976 no Martel systems had yet been sold outside the U.K. and France.[39]

Development work on a ship-launched surface-to-surface version of this missile began in 1970, but was later terminated. There was some government funding in the beginning, but when this ceased, the program continued for a while as a private venture of the two lead firms, Hawker Siddeley Dynamics and Engins Matra. This version suffered from being in direct competition with the French (Aerospatiale and Electronique Marcel Dassault) Exocet ship-to-ship missile, one for which the British government had selected BAC to be the British production partner as part of an offset agreement for a British buy.[40]

In addition, Britain was developing a sub-Martel for launch from a submarine and made a major effort at getting the French to collaborate, but the French were more interested in a submarine launched Exocet. Britain therefore decided to procure the U.S. sub - Harpoon, so the development of the sub - Martel version was also dropped.[41] The British produced the Harpoon under license from McDonnell Douglas.



MARTEL (TV head version) mounted on a British Buccaneer)
Photo: Hawker Siddeley Dynamics

Since the Martel project consists of two very similar missile systems with a high degree of overlap, each government took charge of the development of one of the two missile systems. Each government then procured through its own existing system its allocated share of the work, each accepting the work conducted by the other. The governments had also undertaken to accept each others designs as valid for their own Service's use.[42]

Not only was there no joint governmental project office or prime contractor, but no prime contractors were appointed within each nation. This did not make it easy for the contractors to work closely together, an essential factor for the success of any project.[43]

Even though this management system was successful in eventually developing and producing the two versions of the missile, the system presented very serious difficulties to both the government and industrial sides of the project, which reduced the efficiency of the development program. Not the least of these problems was a direct result of the different procurement systems in use in the two countries. This resulted in a variety of time consuming problems of design control at each of the many and complex interfaces between French and British hardware. E. Evans and P. Lawrence concluded in a NIAG report that the success of the Martel project was "in spite of" rather than "because of" the management procedure adopted by the two countries. If the system was difficult to operate between two nations, it would have been much more so if more than two nations had been involved.[44]

D. THE FH-70 and SP-70

1. FH-70

The origins of the British-German-Italian family of 155 mm close support guns, which includes the FH-70 (the towed Field Howizter of the 70's) and SP-70 (Self-Propelled Howitzer of the 70's) and their associated common ammunition can be traced back to the early 60's. These two projects represent the only major case of joint projects emanating from the NATO Basic Military Requirement (NBMR) Procedures, NATO Document, C-M (59) 82, making it through the full cycle from concept, through design, development, production and into operational use.

By the end of the 1950s it had become obvious that the artillery of the Warsaw Pact countries was superior to that of the NATO countries in almost every way. An especially negative factor was the great number of calibres and the numerous ammunition types for every calibre which were being produced in the U.S., Great Britain, Italy and France.[45] In order to correct this imbalance work began within NATO toward producing an NBMR around which the allies could standardize the next generation of field howitzers.

Almost simultaneously, in 1963, both the UK and FRG MoD's issued General Staff Targets (GST):

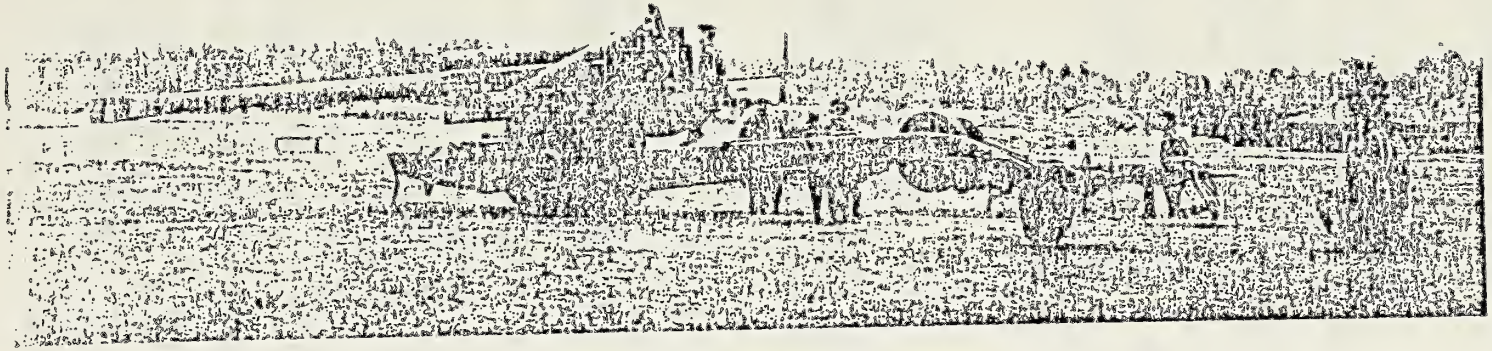
- the British GST calling for a new general support gun to replace its own British 5.5 inch gun; and

—the German GST being drawn up for an improved medium field howitzer, to replace its American 155 mm towed gun.[46]

The draft of NATO Basic Military Requirement (NBMR) 39 was generated shortly thereafter, outlining the characteristics of a Close Support Gun which would have a 155 mm caliber, be capable of firing over a range of 30 km, could have either a towed or a self-propelled mounting, moreover, NBMR 39 pointed out the similarities between the British and German GST. Exploratory talks began between the two nations, joined by the U.S., within a NATO Ad Hoc Mixed Group. The aim was to establish the feasibility of joint development, in accordance with NBMR 39, of both a towed and a self-propelled gun.[47]

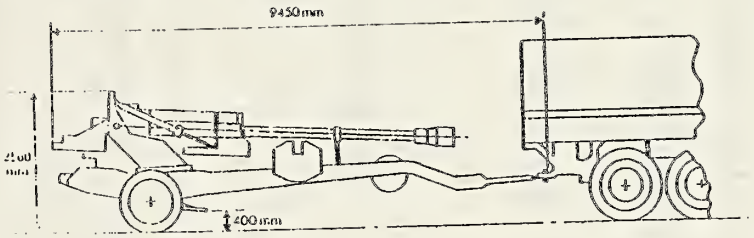
The UK and the FRG were able to subsequently agree on the features of a towed gun, but the U.S. dropped out. Both agreeing nations attached particular importance to the improved suitability for use by reserve units of a towed gun, compared with a self-propelled one. Consequently, on a bilateral basis, the UK and the FRG initiated design studies. The results were incorporated into full-sized mockups, which were compared at a Joint User Presentation in 1966.[48]

With the operational characteristics of the gun thus determined and the signing of an MOU covering development of the FH 70 in 1968, the UK and the FRG launched Europe's first multi-national artillery program. Following With the signing of the MOU the project received endorsement from the North Atlantic Council and thereby became the 'NATO' FH-70 project.

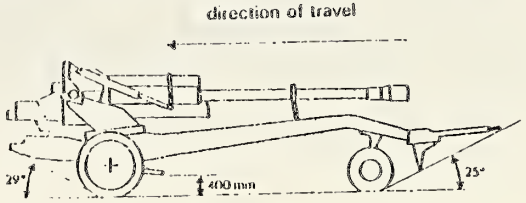


155 mm Field Howitzer FH70 Outline sketches

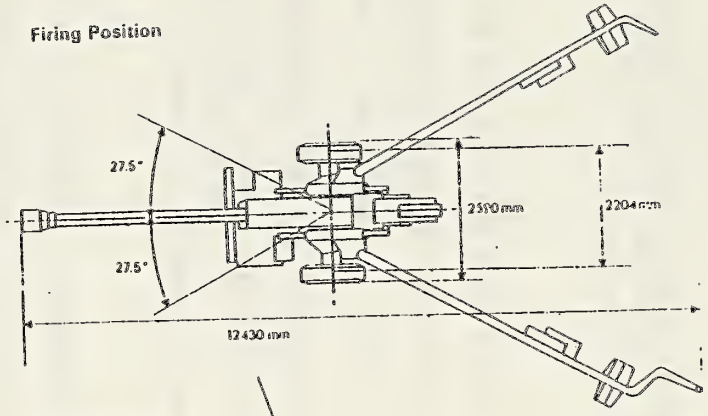
Towed Position



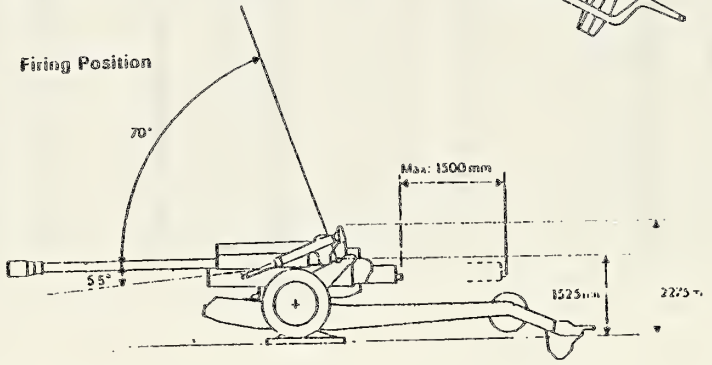
Self-Propelled Position



Firing Position



Firing Position



Source: International Defense Review

In 1970, by which time the six Phase I prototypes had begun their firing trials, the third country, Italy, came in; making this the same tri-national grouping as that of the MRCA project.

Although a standard NATO gun (i.e. an alliance-wide standard) was never developed, a main calibre of 155 mm for self-propelled and towed artillery was selected within NATO. In addition, a quadrilaterial agreement between the U.S., Great Britain, Italy, and the FRG made the established of a common ballistic for this calibre possible, one which is continually monitored in extensive interoperability tests for ammunition components.[49]

The British have project leadership for the FH-70. Operating through the bi-national, and later tri-national, NATO FH-70 Steering Committee are the national authorities with overall responsibility for design and coordination of research and development:

—the UK's Royal Armament Research and Development Establishment (RARDE), and;

—the FRG's Bundesamt fuer Wehrtechnick and Beschaffung (BWB).[50]

On an industrial level there was a single coordinating design authority, Vickers Ltd. (UK). Vickers is also the industry design and manufacturing authority for the carriage, while Rheinmetall GmbH (FRG) is the industrial design and manufacturing authority for the elevating mass. For development other individual responsibilities were broken down as follows:

FRG

Faun-Werk - Auxiliary Propulsion Unit and suspension system;

Leitz-Wetzler - sights;

Moeller - Indirect fire telescope;

Rheinmetall - smoke, illuminating, extended range, direct and indirect fire antiarmour projectiles.

United Kingdom

RARDE/Royal

Ordnance Factories - HE projectiles; charge systems.[51]

Until the production stage was reached, Italy's participation, as a late joiner, was limited largely to technical evaluation and to joint user trials. For Development of the FH-70 was concluded in 1975. Production began in 1976 with Vickers assuming the role of the prime contractor. Service units of the three nations have been converting to the new gun over the second half of the 70's production. The UK/FRG/Italy work sharing percentages were to be roughly 35/35/30. The two principal Italian contractors are OTO Melara and SNIA Viscosa.[52]

In the British Army, the SP 70 will replace the 105 mm Abbot Self Propelled Gun, the American M-109, and the 175 mm M-107 gun. In the German and Italian Armies the M-109G will be replaced.[53] The FH-70 offers significant improvements

over these in the areas of range, rate of fire, mobility, protection, and reaction time.

Not only has the FH-70 promoted interallied Standarization but interoperability has also been addressed. Complying with the NATO standard 155 mm caliber the FH-70 is capable of firing all in-service 155 mm projectiles of U.S., British, German or French design. As one might expect, for the towing vehicles national standarization was followed, each participating nation using vehicles of indigenous design.

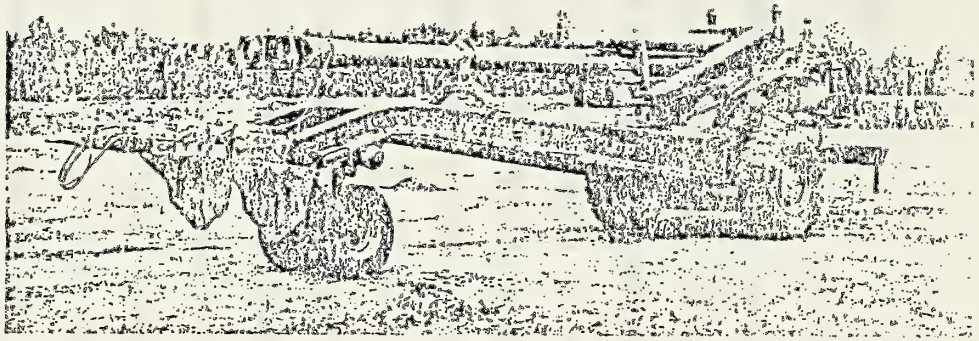
One other notable point on the FH 70 project is that it is the only major jointly developed weapon system to have opted to work through the NATO Maintenance and Supply Agency (NAMSA) in Luxembourg, for follow-on support. The participants of all other such joint development projects have locked out NAMSA and its support services through bi- or multi-lateral arrangements made early on in the projects history. Specifically, for the FH-70, NAMSA currently has responsibility for joint spares supply.

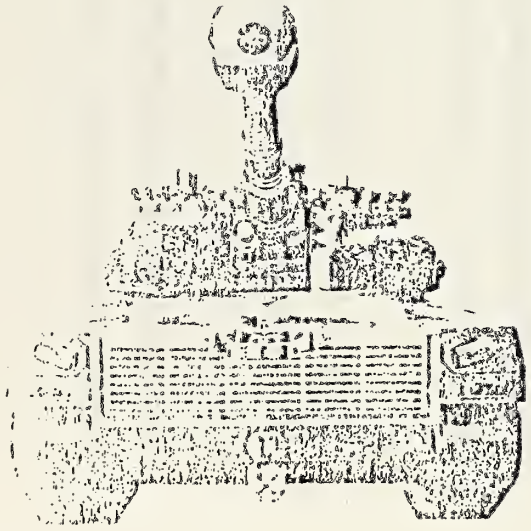
Deliveries of all 73 guns ordered by the British Army was completed in June, 1980. A similar number, out of an eventual total of 214, had also been delivered to the Bundeswehr by that time. Deliveries to the Italian Army, slated to receive 160, had been lagging, however, as a result of a decision to wait for modifications to be incorporated into the production run, rather than have them retrofitted.



FH - 70

Source: International Defense Review





SP - 70



2. SP-70

Whereas the UK had been granted the lead coordinator role in the earlier FH-70 project, the FRG assumed this role for the follow-on SP-70. Moreover, unlike the FH-70 which was developed basically on a bilateral basis (followed by a tri-national production effort) the development of the associated self-propelled howitzer, the SP-70, included Italy from the beginning. The family of ammunition used for the SP-70 is common to that of the FH-70.

At the June 1973 meeting of the Eurogroup defense ministers, the same three partner nations agreed to develop jointly a self-propelled version of the FH-70 and set up the Tripartite Joint Management Committee. Later the same year, the SP-70 was designated a NATO project.

As of late 1979, five prototypes had been built under Stage A of the development program which roughly corresponded to the U.S. concept of advanced development. After the five prototypes of Stage A underwent extensive testing, the ammunition feed was optimized through a concept phase study. These results were incorporated into the ten prototypes of Stage B which were under production at that time.[54]

Though originally expected to enter production in 1981, there has since been a four year slip in the schedule.

As of mid-1981 the development firms in the three partner countries were performing component tests. Tests by the companies producing the system will be

performed in 1982 in the FRG, engineering tests in the three partner countries in 1983, and in 1984 joint logistical and tactical troop tests will be performed in the FRG, so that by the end of 1984 the trilateral joint introduction into service can be approved. Joint production of the SP-70 is scheduled after 1985 under the responsibility of the German general contractor.[55]

The highest decision-making authority for the Project organization is the NATO SP-70 Steering Committee convening semi-annually and composed of one representative of each nation. The executive committee is the next level below this authority: it is made up of the three program directors. The work of the executive committee is supported by a trailateral secretariat which works in the FRG's BWB in Koblenz.[56]

Overall management on the industrial side is by the Technical Project Management Team (TPMT), which is made up of representatives of the three general contractors during the current development phase:

- Italy: OTO Melara with Fiat as subcontractor.
- Germany: Rheinmetall with Krupp MaK, Porsche, MTU and Renk as subcontractors.
- Great Britain: RARDE with the Royal Ordnance Factory (ROF) Leeds and ROF Nottingham as subcontractors.[57]

In the procurement phase a German prime contractor will be responsible for the joint production of the end item on one assembly line. Individual components and sub-systems will be delivered by subcontractors from the three partner countries.[58]

Responsibility for development of the following components and sub-systems was assigned to the three partner countries as described below.

Federal Republic of Germany:

- Chassis and main power pack (except the auxiliary power unit (APU) and fuel system);
- Ordnance, with cradle extension and flick ramming;
- Electrical and hydraulic systems;
- Production of hull, and;
- Reliability and maintenance analysis.

United Kingdom:

- Turret with ammunition handling system and magazine (except elevating mass);
- Traversing gear, and;
- Sighting systems.

Italy:

- APU;
- Fuel system;
- Cradle with recoil system (except ordnance, cradle extension, and flick ramming);
- Combined elevation and balancing system with servo-compensation, and;
- Production of hulls.[59]

In order to reduce development risk and improve logistics support costs, proven components and characteristics of the following four systems would be used as much as possible:

FH-70:

- Gun concept and identical ballistics;
- Breech block wedge;
- Flick ramming system;
- Ring obturator, and;
- Primer magazine.

LEOPARD 1:

- Complete running gear;
- NBC system, and;
- Fire suppression system.

LEOPARD 2:

- Basic motor;
- Final drive, and;
- Driver's seat.

MARDER:

- Gear module.[60]

The SP-70 employees new ordnance mounted in a turret on a chassis which was originally expected to be identical to that of the Future Main Battle Tank (FMBT) under joint development by the UK and FRG from 1973 to 1977. The FMBT joint tank development project though, went the way of its FRG-France and FRG-U.S. predecessors, and was cancelled shortly thereafter. The chassis on the development models have been those of the German Leopard I tank, modified with

a new upper hull structure and new drive sprocket. This chassis had always been the most likely for the German and Italian Armies, since both already used the Leapard I for their main battle tank.[61] It had been far less certain, however, that the British, who do not use the Leopard I, would also adopt this chassis, although they were expected to use the same MTU MB871 engine.[62]

In the last few years, extensive studies in the U.S.A. have also resulted in establishing the requirements for a future howitzer and determination of which gun would meet them. It is interesting that the necessary performance characteristics are with only slight deviations, exactly the same as those which were established by the three partner countries before the development of the FH-70. Recent developments such as the SP-70 and the possibility of increasing the performance of the M-109 A2 with additional retrofit kits were studied, as well as a new U.S. developed system.

The UK, the FRG, and Italy have proposed the SP-70 Howitzer[63] as a candidate to satisfy the requirements of an Army Mission Element Needs Statement (MENS) for an Enhanced Self-Propelled Artillery Weapon System. In May 1978, the U.S. reaffirmed to the Tripartite Joint Management Committee its interest in monitoring development of the SP-70. Technical design data exchanges have since taken place but only on a limited scale.[64]

The U.S. Army had previously requested funds for joining the development program, primarily to assess the technology involved, but the funding had been refused by Congress.

The U.S. Army's program is still in the initial phase, and no firm characteristics or performance parameters have been described. During the concept formulation phase to be completed during FY 82, alternative systems approaches to satisfying mission needs will be identified and evaluated.[65]

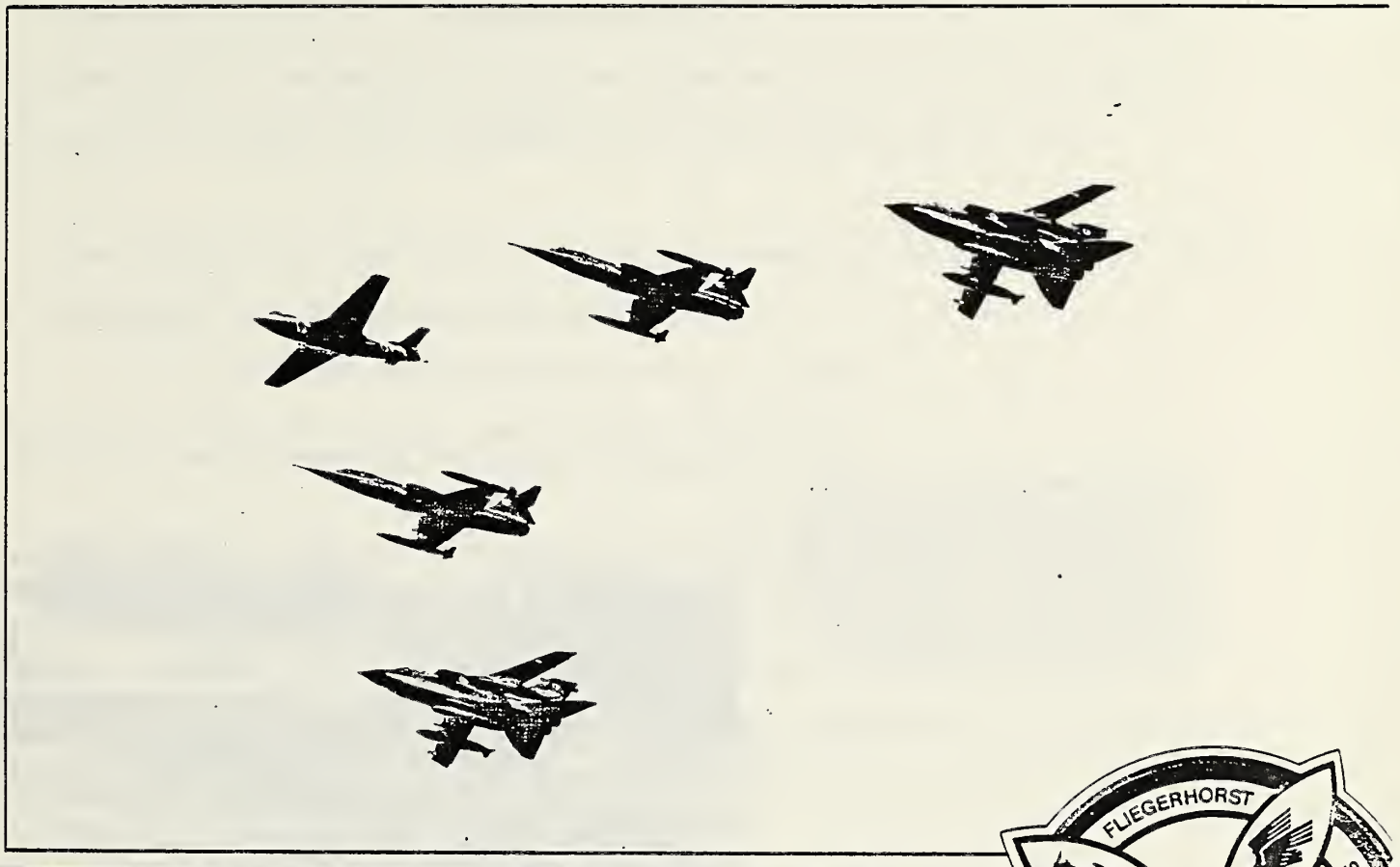
E. MRCA Tornado

First production deliveries of the British-German--Italian Multi-Role Combat Aircraft (MRCA) Tornado were in early 1980. The three nations have ordered 807 aircraft: the U.K., 385; the FRG, 322; and Italy, 100. The MRCA Tornado specification is an amalgam of British, German, and Italian requirements. That is, it will fulfill five roles for the air and naval forces of the three nations:

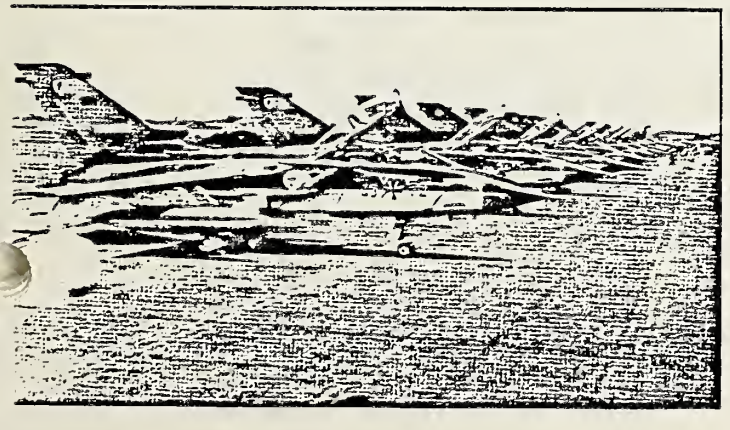
a. Strike and interdiction - for the RAF and the German Navy;
b. Close air support - for all three;
c. Reconnaissance - for all three;
d. Air defense interception - for the RAF;
e. Air superiority - for the Luftwaffe and the Italian Air Force.

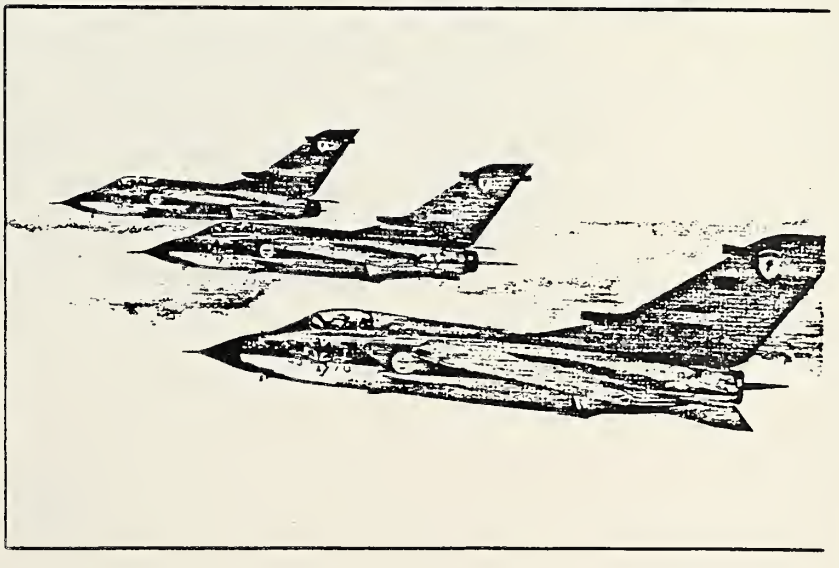
For the Royal Air Force the aircraft will replace Vulcan bombers, Canberras, F-4's, and Buccaneers. By the late-80s over half of the RAF's aircraft inventory will be composed of this particular design. For the Luftwaffe and the Italian Air Force the MRCA will replace the obsolescent F-104G's. The German Navy intends to employ the MRCA equipped with stand-off missiles for the low-level anti-shipping role.[66]

As of mid-December, 1980, 29 production Tornadoes had been turned over to the Luftwaffe, the Bundesmarine, and the RAF. Six pre-series and seven prototype aircraft were also flying.



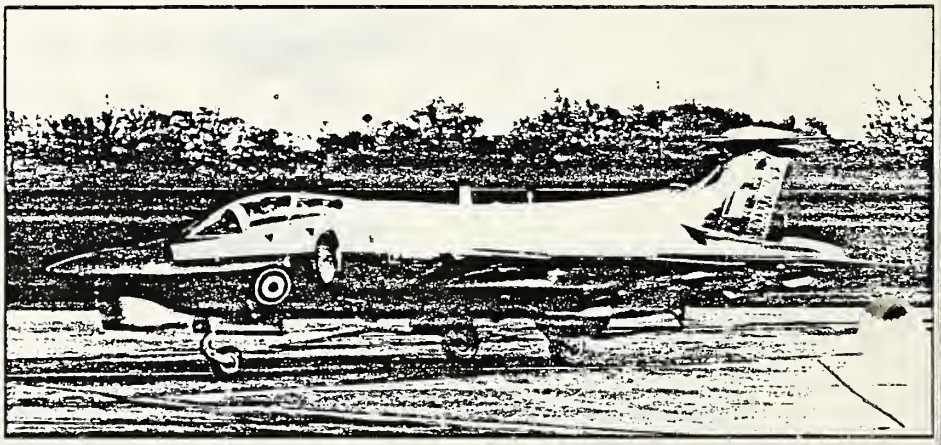






Oben: Überflug unter dem Motto: „Marineflieger gestern und heute". Angeführt wird die Formation von einer Hawker Seahawk, der Erstausstattung des MFG 1 Ende der fünfziger Jahre. Links: Typischer Aufklärungseinsatz von zwei RF-104G im Tiefflug über der Ostsee. Darunter: Exaktes Line-up von acht Tornados des MFG 1 in Jagel. Daneben: Dreierformation von Tornados des MFG 1.

The Royal Aircraft Establishment at Farnborough , England, now has a BAe Buccaneer 2 in its fleet as an advanced avionics flight test vehicle. It has been flying for the last two years with a nose-mounted wide angle FLIR and extensively modified cockpit for the Nightbird trial. The chin turret seen in this view is for a GEC Avionics narrower-FOV TICM II thermal imager, with sightline steering through a Ferranti stabilised mirror, and possibly a laser ranger. This equipment is now being installed and flight testing will begin next month.



Some 70,000 people will be employed over much of the first half of the 80's on the program. The MRCA's unit cost was quoted at $15.4 million in mid-1978[67] and total program cost is expected to be in the region of $22 billion.

The variable wing geometry is essentially the result of two mutually-conflicting but highly important military parameters:

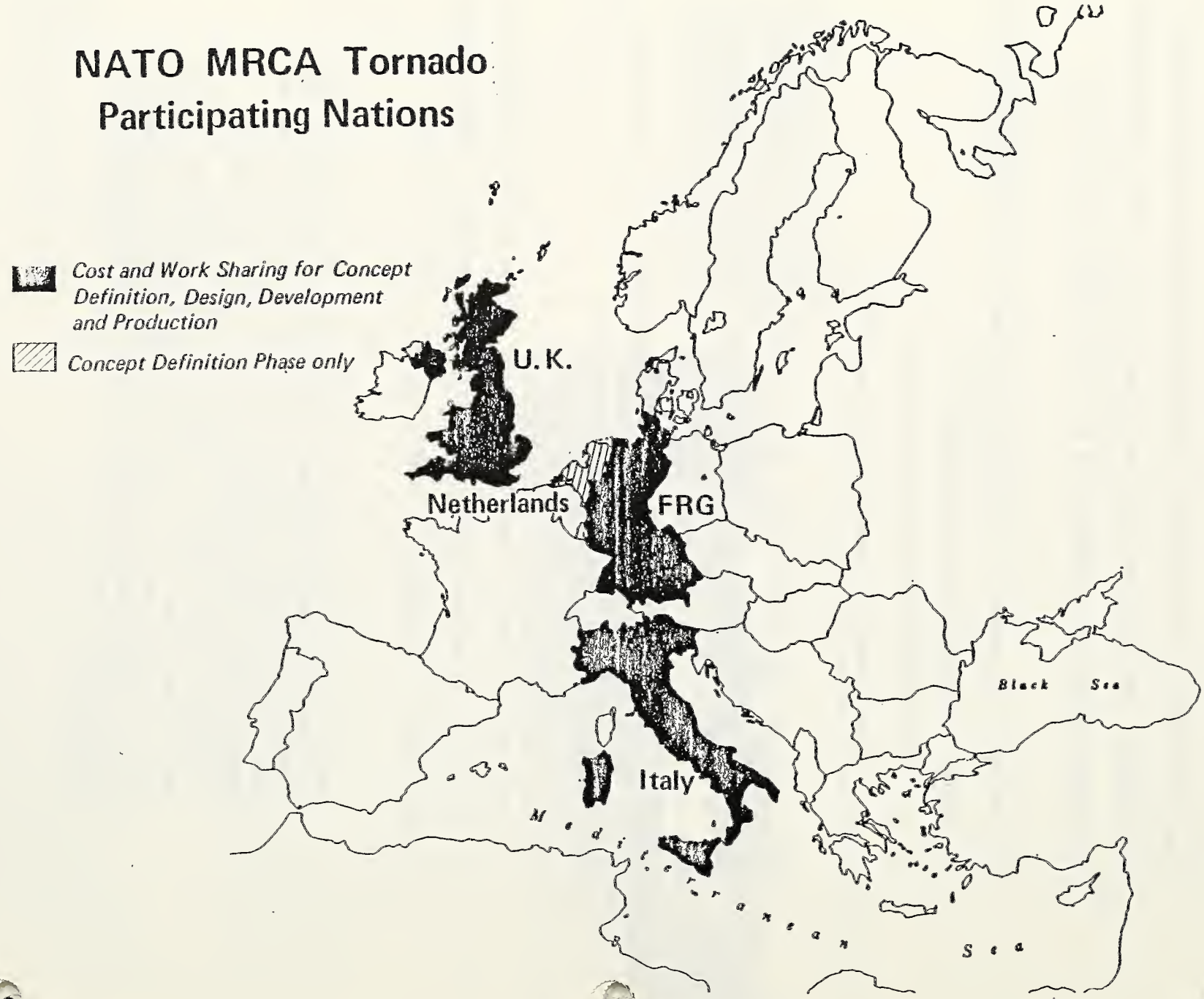
- short take-off and landing capability, and;
- high (transonic) speed at very low altitudes.

While the STOL requirement demands the provision of high lift and good low-speed maneuverability, through the use of the highest possible aspect ratio, the high-speed, low-altitude role requires the lowest aspect ratio possible, coupled with a high wing loading to minimize gust sensitivity and so ensure optimum low-level performance characteristics.[68]

For many years to come, the Mach 2.2 MRCA will be the only NATO aircraft with a multi-role, all-weather combat capability. With regards to weather, General Limberg, Chief of the German Air Staff, said at a lecture in 1977:

> "We have assessed what would have happened if, at the time of the Yom Kippur war, Germany had been attacked rather than Israel. Our studies indicate that if the first days of the Yom Kippur war had been fought in weather conditions prevailing at that time in Northern Germany, none of today's aircraft could have operated effectively with conventional weapons, except the F-111. Without an all-weather weapons system, it would have been much harder for us than for the Israeli Air Force to stop the enemy's tank attacks and thus to provide sufficient time for the deployment of our ground forces. Under these conditions, the use of nuclear weapons would have had to have been considered at a very early stage of the conflict."[69]

NATO MRCA Tornado
Participating Nations



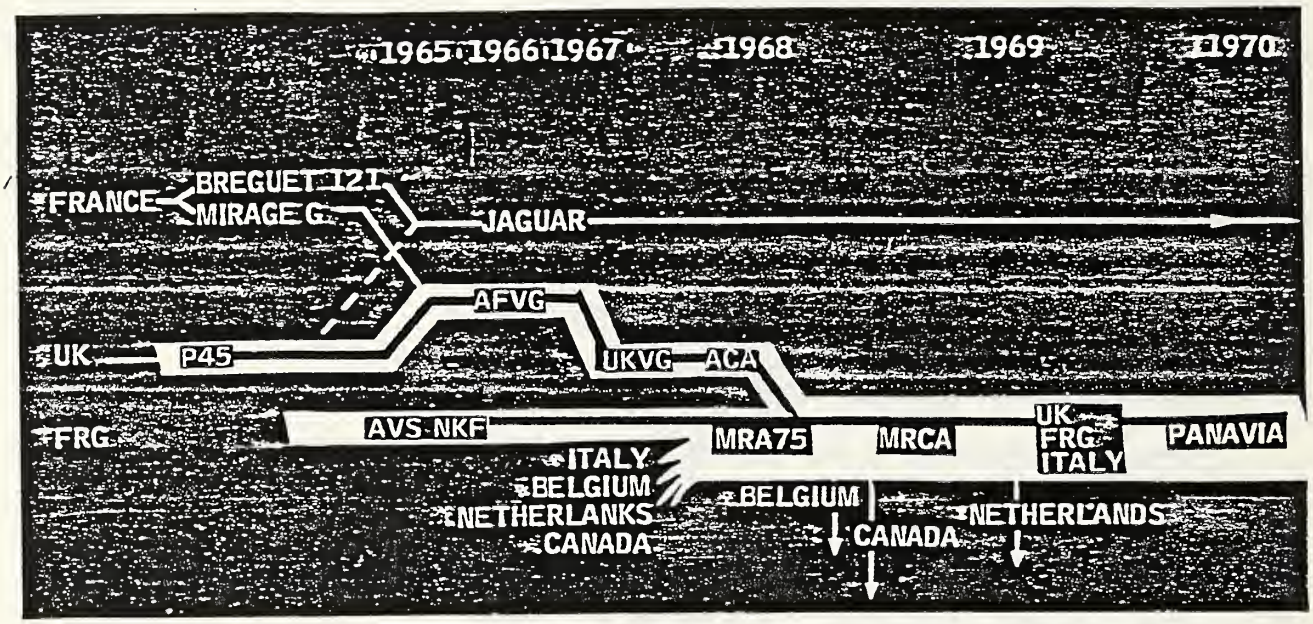
In addition to the gun, ordnance for the various versions of the MRCA includes: the AIM-9L Sidewinder (see Chapter 7), the Skyflash air-to-air missile, the Martel air-to-surface missile, and the Kormoran anti-shipping missile.

1. After a Protracted Deadlock Over Project Leadership A Four-Nation Consortium is Formed; Belgium and Canada Withdraw (May-November 1968)

This largest ever of Europe's joint weapon system programs was officially launched back in July 1968 when the U.K., the FRG, Italy and the Netherlands signed an MOU to establish a common design and consolidate the various concepts for managing the MRCA program into a working agreement.

Earlier in 1968, the AVS[70] program (U.S.-FRG V/STOL fighter), at the time considered by the FRG as a replacement for the F-104G,[71] had been cancelled by the American and German governments. It was cancelled for a number of financial and technical reasons, and because it appeared that the time for an advanced V/STOL combat aircraft had not yet come.

With the cancellation of the AVS program, the Luftwaffe decided in early 1968 to replace the Fiat G-91[72] (NATO LWSR fighter) and the F-104G by a single aircraft tailored to the military geography of the FRG and the strategic and tactical missions of the Luftwaffe within NATO. In the case of the previous F-104G, major modification of a foreign developed system originally tailored to differing requirements had proven to be of questionable cost/effectiveness. The FRG proceeded to try to interest those other NATO nations that had been involved in licensed production of the F-104 (Belgium, Canada[73], Italy and the



SOURCE: AVIATION WEEK AND SPACE TECHNOLOGY

Netherlands) and who would also be needing a replacement over the second half of the 1970's, in their concept of a Neukampfflugzeug (NKF).[74] At a meeting of Chiefs of Air Staff of the five NATO-countries in Rome in May, 1968, an Agreement was reached concerning the main characteristics of the development of a European Combat Aircraft (ECA) and a rough plan of development. The results of discussion were transmitted to the participating governments.

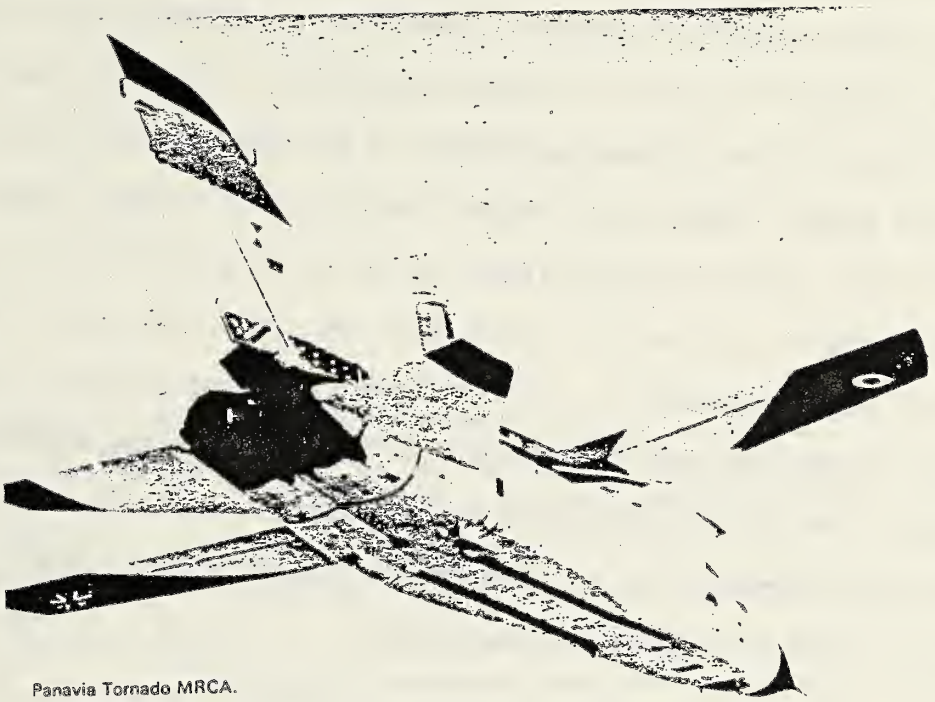
As a result the high-level NKF Joint Working Group was formed within NATO to coordinate a number of national feasibility studies and the individual national service requirements. France showed no interest, but the U.K. expressed interest in a joint European fighter program in view of a similar requirement. The British themselves were in search of new partners since their previous joint development program, the Anglo-French Variable Geometry (AFVG)[75] fighter, had also collapsed. The French were content to proceed unilaterally with their own low-level effort but the British were not.[76]

Two months after the initial MOU had been signed in July, Belgium and Canada also signed, while France announced its intention to do so.[77] France, however, never did join, and Belgium and Canada withdrew later in the year.

After several months of deadlock over project leadership between Messerschmitt-Boelkow[78] and BAC - both backed by their respective governments - a compromise was eventually found in the establishing of an international firm, Panavia GmbH, in late fall 1968.[79] This deadlock had continued through most of second half of 1968.

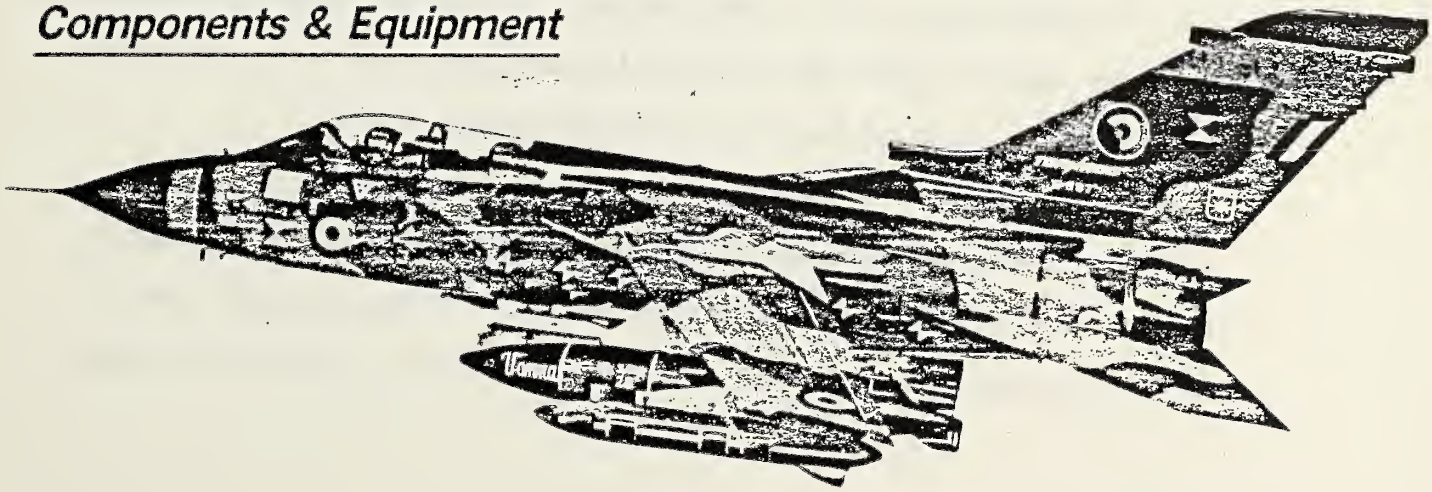
In the interim, Messerschmitt-Boelkow (MB) had been pressing for design/project leadership on several grounds. First, with regards to estimated requirements the FRG would require more than one half, and Britain less than one quarter of the estimated total production figure. Secondly, there were fears that too strong a foreign influence would completely change the German concept of the new aircraft. Third, the Germans felt that the size of its aircraft industry compared to the U.K.'s was irrelevant and that the only determining factor should be potential and "know-how" required for the task, something the German aircraft industry felt it had, and wanted to prove. They cited as evidence of this the fact that the FRG had received design leadership in the AVS program, i.e. even the U.S. was convinced of German potential as regards design, development and testing. MB's final major argument, and one for which it had the full backing of the German Ministry of Defense, was that the Lutfwaffe would be the first air force to receive the new combat aircraft and therefore would be assuming a greater risk and needed to ensure direct and unlimited communication between the major contracting authority (the German government), the project leader (MB), and the first user (the Luftwaffe). Further heightening German sensibilities on this score was the fact that throughout this period the two leading British aircraft companies were running a wave of advertisements in German newspapers pushing for design leadership, promoting their capabilities and both claiming to be Europe's largest aircraft company.[80] The Germans, and to some extent the Dutch and Italians, also expressed serious concern over the U.K.'s past record of cancellations in the funding of purely British projects.

For their part, the British claimed the right of design/project leadership on the grounds that they had the largest and most technologically advanced aerospace



Panavia Tornado MRCA.

Components & Equipment



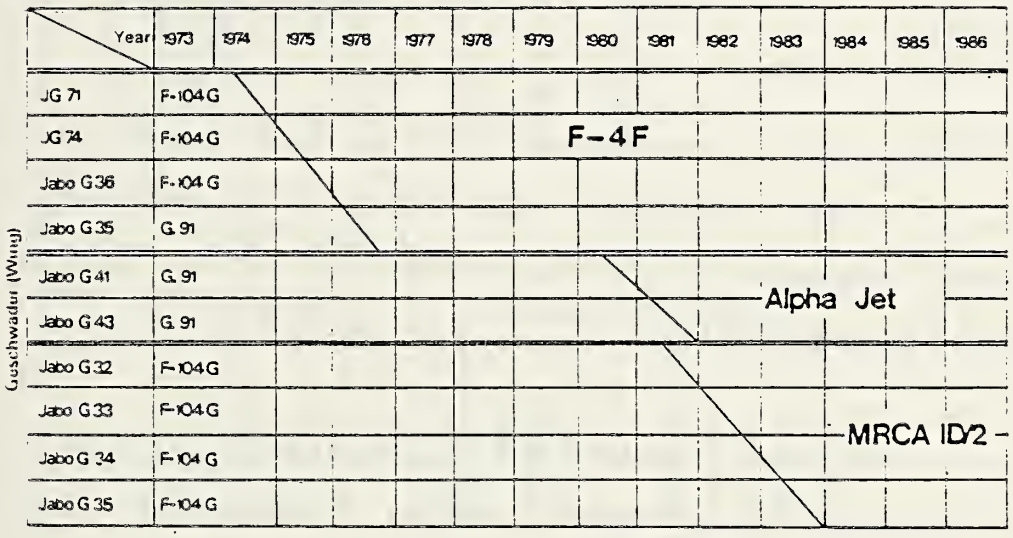
industry in Europe, not an inconsiderable factor. Britain requested that the German industry submit a summary of capacities and capabilities to prove that it could justify its claim to design leadership.[81] The British were once again faced with the dilemma encountered in the Jaguar/AFVG fighter package, that of a clearly higher technological capability in avionics (some 37% of MRCA's total cost) and engines (28%), but being able to claim only an equal or smaller share of total work in development and production, due to the share of the total of its national order. Furthermore, in consideration of the prestige factor involved in choice of the airframe, and the necessity of a compromise here, the British would have to transfer a considerable amount of technology and know-how to its continental competitors as a result of an equal sharing of work in avionics and engines.[82]

Considerable concern was expressed at this time as to the possibility that the program was going to be irreparably damaged by British-German in-fighting.

In the eventuality of there being no agreement reached between the FRG and the U.K., it appeared that both might have to continue with their respective national programs independently; the British with the advanced combat aircraft (ACA) and the Germans with the NKF program. For the NKF several alternatives were under consideration, one of which included participation of the Boeing Company (owning 33.3% of Boelkow) in system engineering.[83]

In October, 1968, the Germans finally came up with the compromise proposal which eventually broke the negotiating deadlock. This was accomplished by both sides agreeing to the formation of an international industrial company

Re-equipment programme for West German Air Force operational units



Source: Interavia

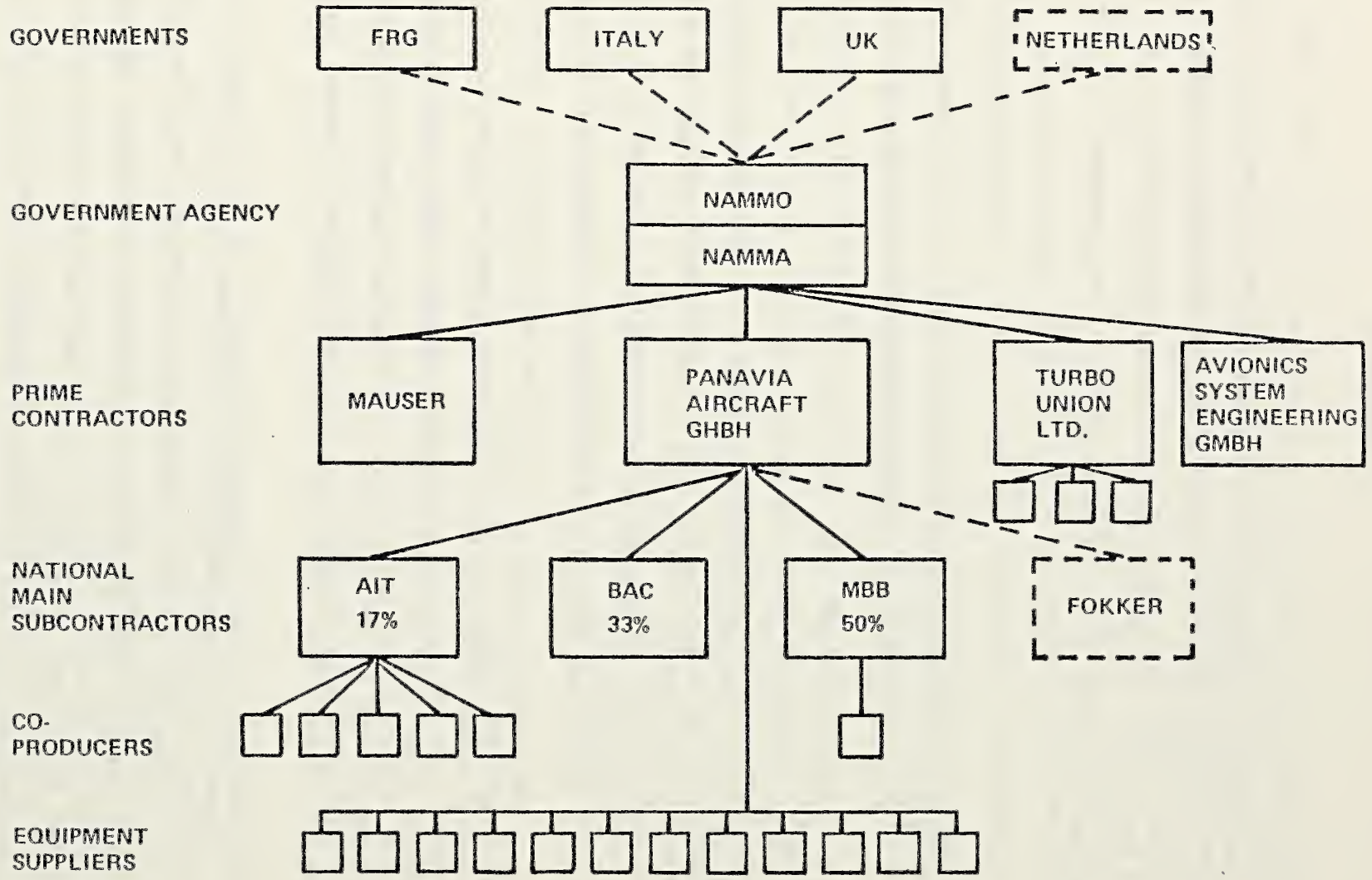
that would develop a system concept for the advanced European fighter. Though the prior track record of such international prime contractors for weapon system projects was at best marginal, no other politically acceptable solution was available. Furthermore a great deal of experience had been accumulated from the earlier projects, that applied to this one, would make a considerable difference.

2. Three Nations Sign a Systems Definition MOU (May 1969), but the Dutch Hold-back

As of early 1969 the two governments were still far apart in their choice of an engine. The Germans favored the Pratt & Whitney JTF-16, while the British pushed the Rolls Royce RB.199 which they assured their partners would be ready for prototype testing by 1972.

Another major problem area, involving the Italians as well, was the differing military requirements and replacement schedules. Britain wanted a long-range twin-engine, two-seat intercepter/interdiction aircraft, weighing about 40,000 lbs., and with a Mach 2.2 dash speed. The FRG wanted a single-seat, single engine, close support fighter with a radius of only 200 miles and a maximum speed of Mach 1.8. Italy wanted a single seat air superiority fighter. In addition, whereas the British did not need a replacement aircraft until 1978, the FRG originally needed one by 1975. In addition, the FRG was under strong pressure from the U.S. to drop the project all together and buy an American plane.

MRCA Tornado (Systems Definition)



As for the possible selection of a U.S. engine, both Pratt & Whitney and General Electric (the latter ultimately declining to bid) were concerned that proprietary information would be available to competitive firms on the source selection board - particularly Rolls-Royce. As part of their proposals, the competing firms, Pratt & Whitney and Rolls-Royce, were also required to specify the amount of engine work that could be accomplished in Europe.[84]

In May 1969, the U.K., the FRG, and Italy signed an MOU, beginning the systems definition phase of the MRCA project - the Dutch demurred and then decided not to sign the following month. The Dutch rejected the twin-engine MRCA design, because they wanted a less expensive, lighter, and more maneuverable single engine aircraft. The Dutch further explained that their Air Force had determined that large numbers of inexpensive aircraft had become more important than a few highly complex aircraft in meeting its NATO flexible response mission.[85] The Dutch had come to believe that the MRCA aircraft would ultimately be optimized around a tradeoff of interests between the British and Germans, and that technical compromises would be made at the expense of the other countries in the consortium.[86] The Dutch then set about promoting the formation of an alternative consortium that would not have large-scale development costs, but still allow for the participating nations an adequate share of the production.

While both the Netherlands and Italy were anxious to meet their NATO commitments while still retaining aircraft production competence, neither country was as eager for design and development as the other two consortium members. Italy's previous record in such military joint design and development projects was a rather dismal one. Italy had been an early drop out the first three European

joint development projects: the Atlantic Maritime Patrol Aircraft; the first Franco-German tank projects; and the C-160 Transall cargo/transport aircraft. Italy later did procure systems resulting from the first two of these projects, but only through some ad hoc production participation arrangement. This trend, involving a marked inability on the part of Italy to make long-term commitments to such investments, was apparently to continue.

The Dutch started talks immediately with Belgium, Norway, Canada, Denmark and Italy. The Dutch were interested in evaluating the Northrop P-530 (later evolving into the YF-17 and F-18), the Lockheed CL-981, Dassault Mirage F-1 and G, the Saab Viggen, and two undesignated German projects.

The Netherlands succeeded in interesting Norway and Canada by January, 1970. The three agreed formally to conduct a tripartite evaluation of a successor aircraft to the Lockheed F-104 fighter. The Dutch-led project was called the "mini-MRCA" because its object was to obtain a cheaper and less complex airplane than the MRCA.[87]

During the following weeks, technical and operational experts met to develop an exhaustive questionnaire that was to be sent to their aircraft industries. On the basis of the answers, the three countries hoped to be able to select a basic aircraft that could be modified to meet specific requirements by the individual air forces. Canada, for example, was interested in a long-range aircraft, which would not be a Dutch or Norwegian requirement. The three countries were aiming for aircraft introduction in 1974 and hoped to select the basic model within 18 months. Norway did not have an aircraft industry,

but both Canada and the Netherlands were insisting on some development and production work associated with the new fighter.[88]

In rejecting the MRCA, the Dutch had asked Panavia to conduct the evaluation, reasoning that this would increase Panavia's capability by giving the existing consortium a second project, one that could be built under license. The three MRCA countries turned down the Dutch proposal in 1970, however, with the explanation that they feared a substantial delay in the MRCA if the second program was assigned to Panavia at that time.[89] Though these initial Dutch efforts led no-where over the short-run, they ultimately led to the formation of the F-16 production consortium (Mode #7, Chapter 12) in 1975. Italy on the other hand continued to participate in the MRCA as a minor partner. The Dutch government for its part, withdrew officially from NAMMA in early 1970, and Fokker from Panavia, after the failure of the mini-MRCA effort.

The mid-1969 Dutch decision had had little immediate impact on the prospective order base. The original orders had been: the FRG, 600; the U.K., 300; Italy, 200; and the Netherlands, 100. But just prior to the Dutch cancellation of their tentative order of 100, the British upped theirs by 85, bringing a net loss of only 15 orders. The new work-sharing arrangements as of mid-1969 were thus the FRG receiving work totaling 50% of the program, the U.K., 33% and Italy 17%. Within this overall division the Rolls-Royce RB.199 split was to be 52% for MTU, 32% for Rolls, and 16% for Fiat.[90]

The system definition phase MOU signed in May, stated that about 85% of the aircraft was to be common, with commonality in avionics of at least 60%. How-

ever, while the U.K., with its highly developed avionics industry was following a policy of 'Buy British,' the FRG strongly favored opening the competition for avionics to American firms (presuming that the U.S. Deferse and State Departments granted the necessary export clearances) so as to obtain more competitive pricing and a greater transfer of technology and manufacturing competence to German industry. In addition whereas the U.K. and Italy wanted a twin engine aircraft, the FRG wanted a single engine one. Many observers in both the FRG and U.K. at this time began to feel that there was no reasonable solution in which a large degree of commonality could be achieved; common avionics in particular seeming to be an impossible goal.[91] Based on its own experience with the F-111, the U.S. was skeptical as to whether a European multi-role aircraft, in its true sense, was even possible.

In August 1969, an avionics consortium was formed, Avionics Systems Engineering GmbH, to provide project planning and coordinate activities. This arrangement proved to be unworkable, and management of MRCA avionics development was later turned over to Elliott-Automation Space and Advanced Military Systems as subcontractor to Panavia (i.e., not directly to the intergovernmental contracting authority, NAMMA), which in turn subcontracted to: a German consortium Electronik System Gesellschaft (ESG) (consisting of SEL, Rohde & Swartz, Siemens and Telefunken) which was attempting to create an avionics systems engineering capability that didn't exist at that time in the FRG; and an Italian consortium consisting of some eight firms, Societa Italiana Avionica (SIA).[92]

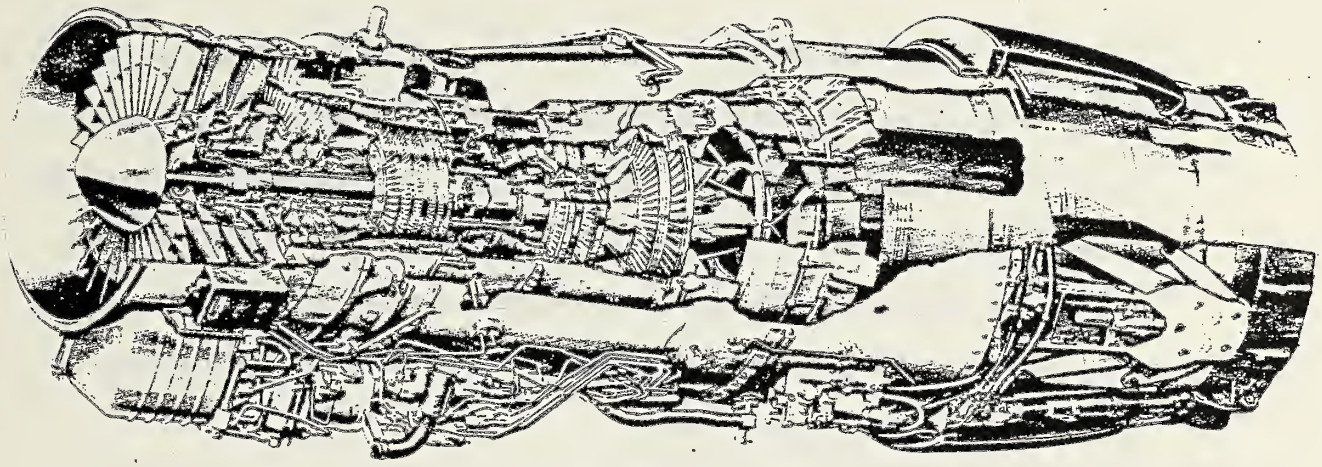
3. <u>The Rolls-Royce RB.199 Design is Selected Over the Pratt & Whitney JTF-16 and Turbo Union Ltd. is Formed in September 1969.</u>

In September, the Rolls-Royce RB.199 was selected for the MRCA and an international company, Turbo Union, Ltd. was set up to coordinate joint engine development. Earlier that year British Defense Minister Denis Healey had stated that although the engine and avionics competitions were still open, importance would be attached to making the project entirely European.[93] After selection of the Rolls-Royce RB.199, NAMMA was under specific instructions not to brief P&W on the reasons that its entry had not been selected. It had become clear, however, that the ultimate decision had been a political one, the decision having been made at the political level well before the technical evaluation was completed, and that the MRCA powerplant selection had set a pattern, one with which U.S. companies would be forced to deal with in the future in Europe's military markets.[94]

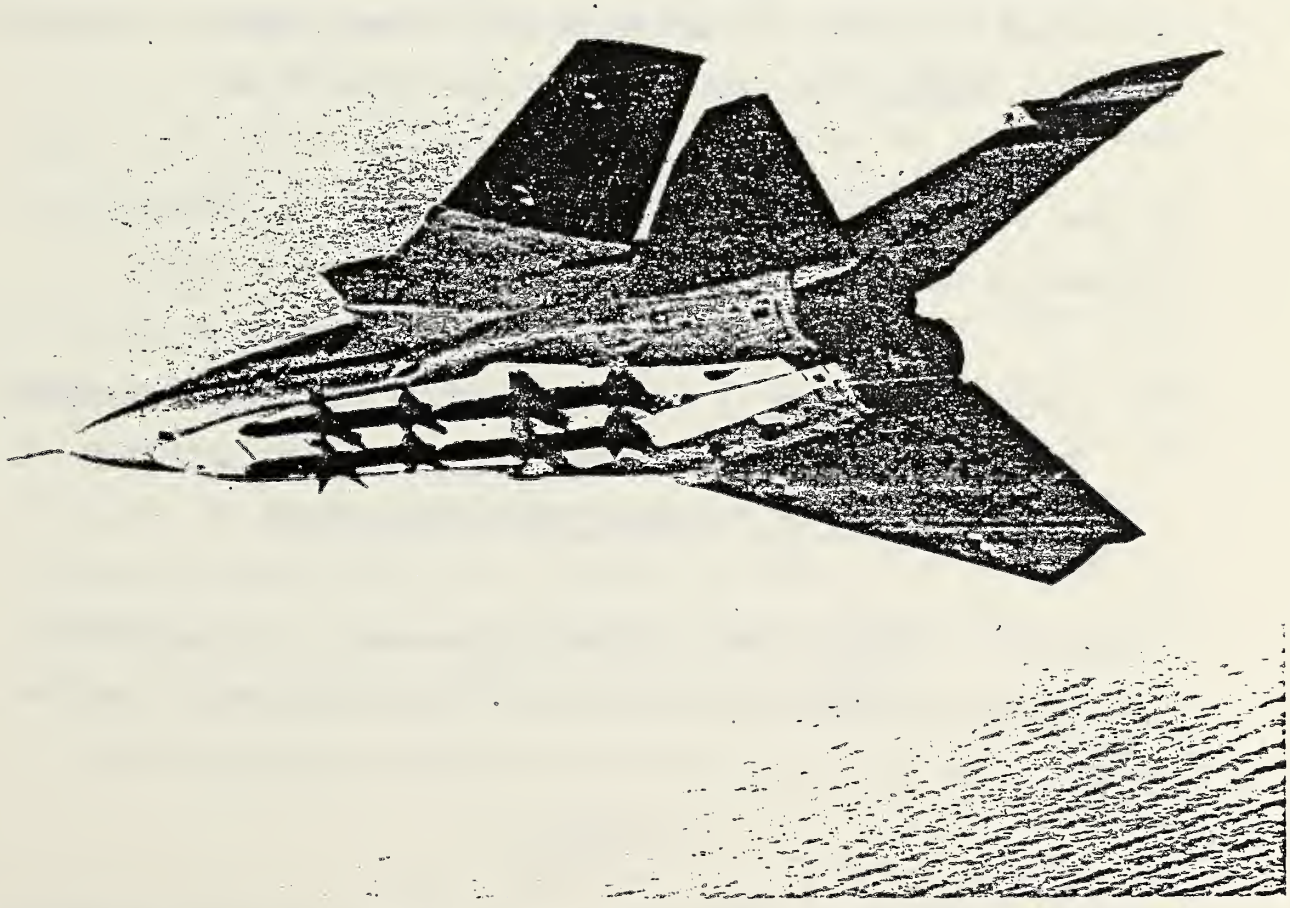
With the odds heavily against their ever getting past a British veto and being selected on a common basis, the P&W proposal was targeted toward the FRG and Italy.

A fundamental difference between the Rolls-Royce and P&W proposals had been that the American company had agreed to subcontract 35% of developmental work to Germany and Italy but would retain, as prime contractor, 100% of the risks. In addition, the P&W development price included tooling costs, whereas participating companies in the RB.199 would provide their own capital equipment.[95]

Also in September, the three engine companies:



Coupe partielle d'un RB 199 de série (Rolls Royce).



Survolant la côte britannique un Tornado ADV. Air Defence Variant armé de quatre missiles air-air Sky Flash. La Royal Air Force disposera aussi de la version IDS (Doc. Panavia).

- Established milestone dates;
- Issued 21 specifications for engine accessories, and;
- Established a deadline for defining the engine, particularly with respect to basic cycle and sizing, compressors, turbines, shafts, combustion chamber, casings and mountings and gearbox and accessory drives.
- Terms of reference also were established for contracts, experimental manufacture and test facilities.[96]

In the engine memorandum of understanding (MOU), termination guarantees established were in proportion to the work sharing of each of the partners, to a maximum of $12 million in the development phase. These guarantees would be increased in the production phase.

The memorandum of understanding also called for payment by Turbo Union to Rolls-Royce of a royalty for each engine sold in consideration for the basic design and background work the company has done on the RB.199.

At least 2000 RB. 199 engines will be manufactured for the Tornado, representing the largest powerplant program ever launched in Europe.

4. A NATO Project Office is Established (NAMMO), the Prototype Development MOU is Signed, and the Program Manages to Overcome its Last Major Obstacles to Survival (September 1969-September 1971)

It was also in September 1969, that the intergovernmental body, the MRCA International Management Organization (IMO)[97] was established by the North Atlantic Consul as a NATO Production and Logistics Organization (NPLO),

becoming the NATO MRCA Development and Production Management Organization (NAMMO). Previously the IMO had prepared all contracts which were then issued by the three governments, but now as an NPLO, its Agency (NAMMA) could award contracts directly on behalf of the three.[98] Also as an NPLO, NAMMO would enjoy the usual tax and tariff advantages.[99] NAMMO represented the first use of an NPLO for the development of a weapons system.

As the systems definition phase was reaching completion in early 1970, opposition to the program and its cost, increased within the Bundestag and among the Military Services of the three participating nations. Italian support for the program was especially in doubt, and the U.S. government and industry increased pressure on the Germans to withdraw. In order to hold down the spiraling cost estimates the Italian and German Defense Ministers agreed to abandon the single-seat version in March 1970. This resulted in a cut in predicted development costs of over 20 percent.[100] Unfortunately, this in turn led to a major decrease in provisional orders by the Germans from 600 to around 400[101] and for the Italians from 200 to 100. Britain again increased its order, which by this time had slipped to 385, back up to 400.

The Luftwaffe re-equipment program chart displays the inter-relationships between the FRG's five major tactical fighters in operation as of 1980. Though the MRCA was originally to be the replacement aircraft for both the G.91 and the F-104G, replacement schedule imperatives and the need to balance its procurement relationships with all three of its major allies (and especially the problematic U.S. one), will mean that the FRG will have a three- instead of a one-aircraft tactical fighter force by the mid-1980's.

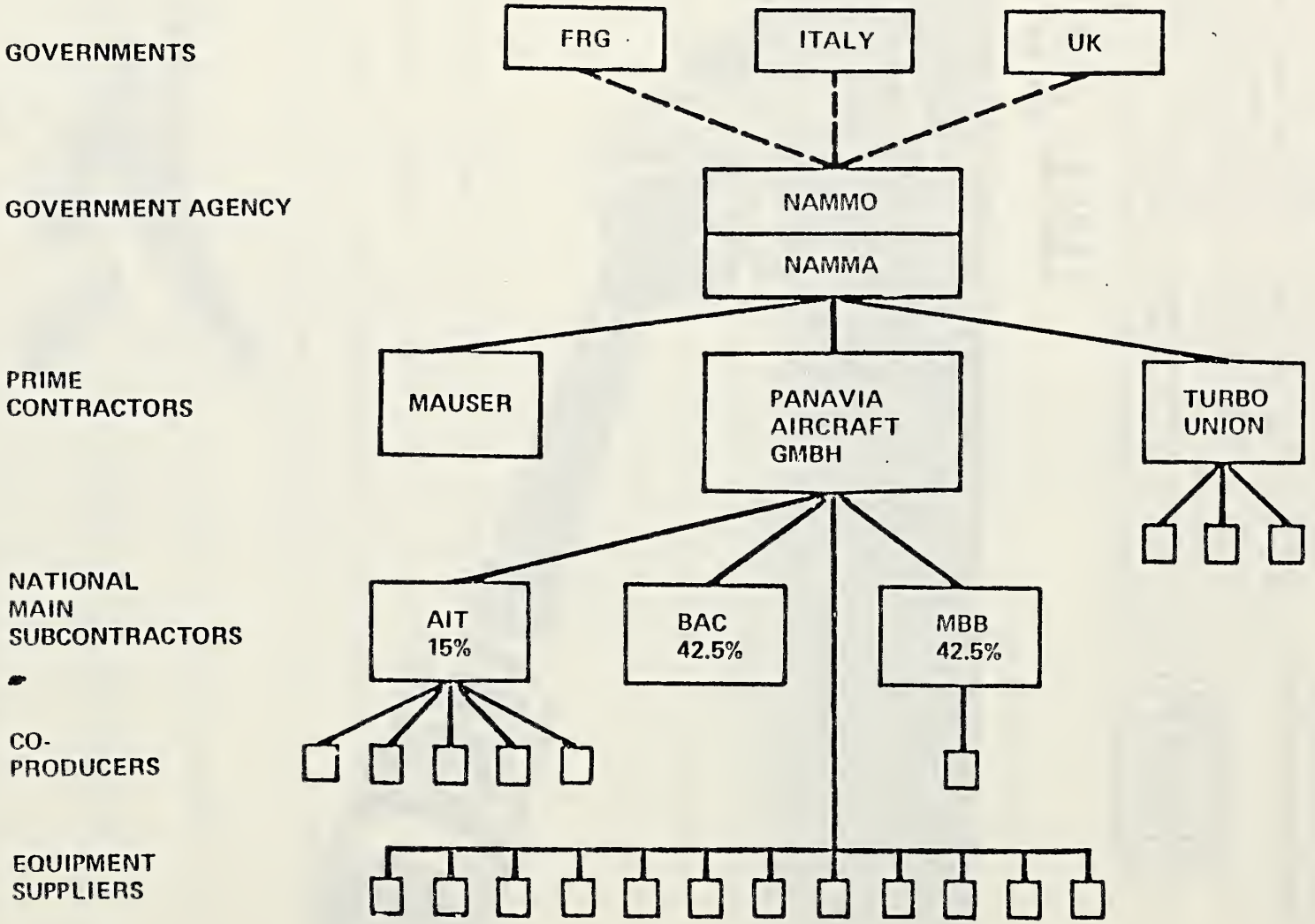
The start of prototype development was approved in July 1970, first by the FRG, and then shortly thereafter by the U.K.; and the program lurched forward again. Development costs at this time were estimated at $675 million and unit costs at about $4.4 million. During the same month Italy, whose ability to participate now appeared doubtful, was offered loans by the U.K. and the FRG, as an well as an advantageous funding/work sharing arrangement during development, which contributed to the Italians finally signing the MOU covering the prototype development phase in October.

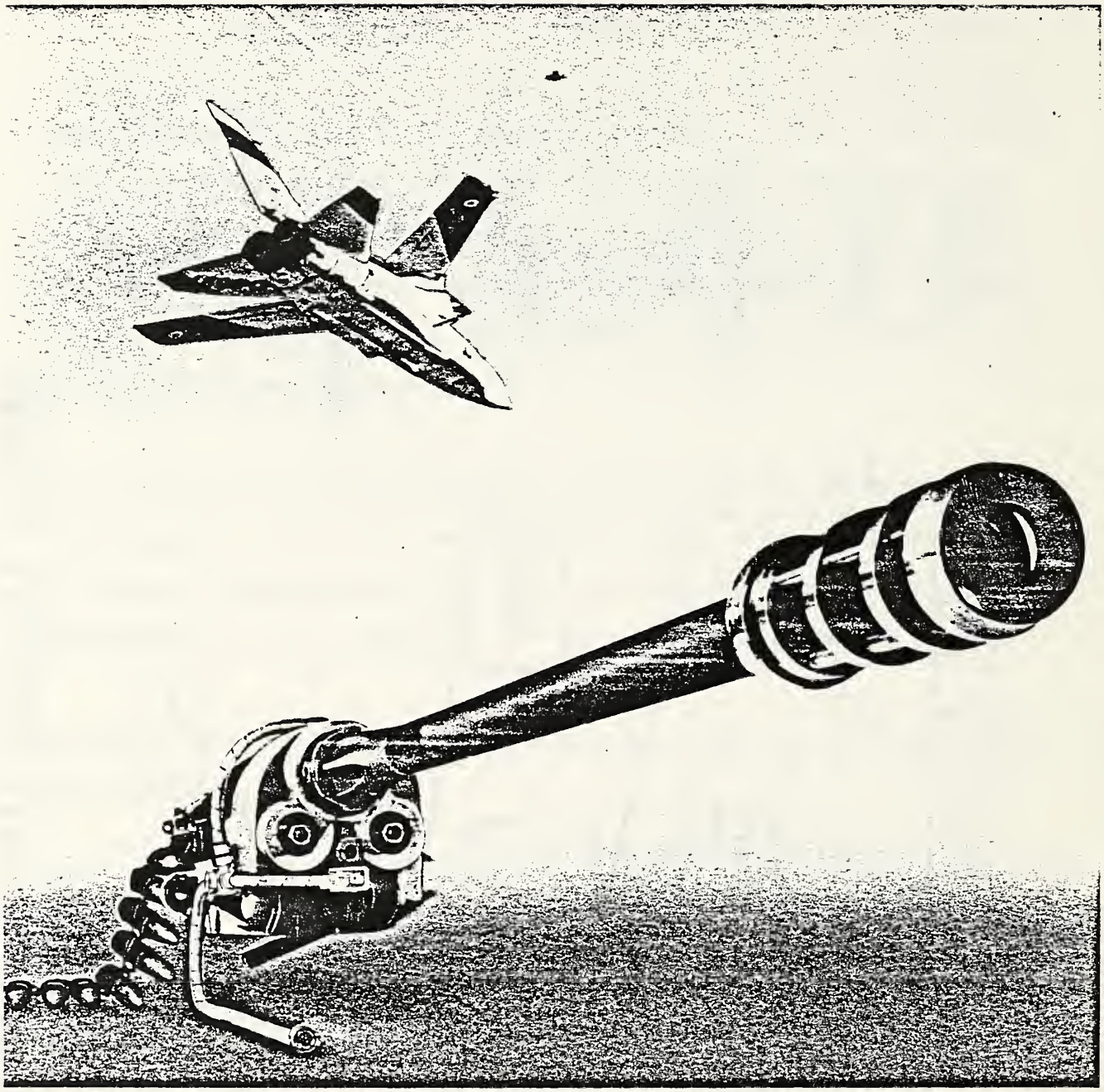
Over the last half of 1970 Rolls-Royce's financial problems had become increasingly apparent. This finally resulted in Rolls-Royce filing for bankruptcy followed by a reorganization in early 1971 with the British government as sole shareholder. All this, reportedly, with no major disruption to the program.

The program was reviewed and approved in September, 1971, by the three participating governments.

Shortly thereafter, in an effort to further reduce development costs, Texas Instruments was awarded a $168 million contract for its mapping and terrain following radar - to be installed in all three nations' versions of the aircraft, providing for night/all weather operations capability.[102] The system, the AN/APQ-110, was developed from the one employed on the USAF F-111, the AN/APQ-128 and was comparable to that intended for the Rockwell B-1 strategic bomber. This one system accounted for over a quarter of the cost of the entire avionics system—a decision that grieved the British and their competing manufacturer. But then the FRG had relented on the previous major source selection issue

MRCA Tornado (Development)





MK27mm

Continuing our tradition as manufacturers of automatic weapons, we have developed – within the context of the MRCA program – a self-powered 27 mm calibre automatic cannon with drum feed, which features an extremely high rate of fire right from the first round for air to air combat, and a lower rate of fire for air to ground use.

By optimization of the installation parameters (small installed dimensions, low weight, lower recoil forces), a wide spectrum of possibilities for mounting and utilization are offered, so that maximum target effect is obtained by various types of ammunition utilizing the most modern configurations of fuzes, explosives and projectiles.

MAUSER

Mauser-Werke Oberndorf GmbH
An Enterprise of the IWKA-Group
Mauser gun systems
D-7238 Oberndorf/N.

UW 2–78

involving a minimal cost/risk approach (i.e. buy U.S.) versus one involving a promotion of European capabilities (i.e. buy British).

5. Program Milestones, 1972-1980

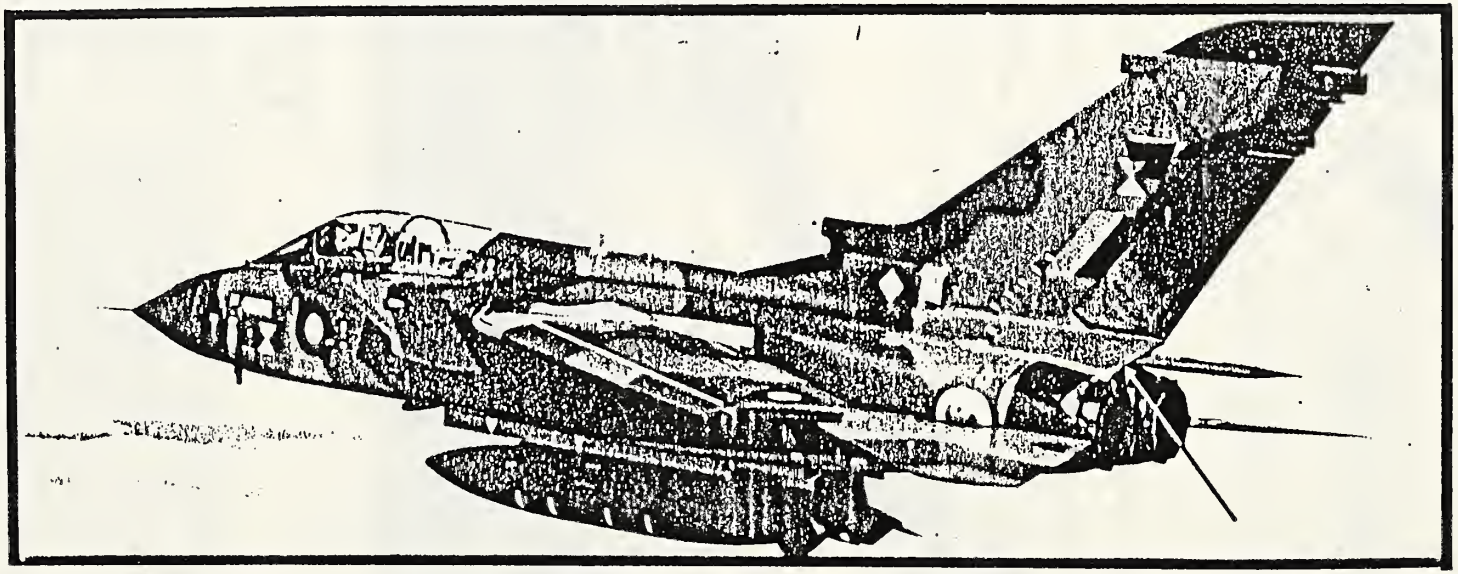
(a) Engine Problems, Slippage, and Cost Increases (1972-1974)

The main development contract between NAMMA and Panavia GmbH, giving final approval for construction of nine prototype aircraft, was signed in August 1972. At this time the FRG further reduced its commitment from what had since increased to 420, down to 322 units, citing cost increases as the major factor.

In addition, during the same year, the development of the avionics package, and especially the engine, had begun to fall seriously behind, the MRCA's first flight not occurring until August 1974. The engine's development proved to be the major—and most expensive—problem faced during the program.

The engine is among the most advanced system used on the aircraft. Employing a proportionately large amount of new technology, developmental problems were not unanticipated.[103]

In February 1974 the report of a British parliamentary select committee stated that the British share of the common development program had increased in real terms by 25% since 1971, this being mainly due to "better definition" of the RB.199 engine program. In addition, inflation brought the U.K. increase to 67%, with currency fluctuations being responsible for adding another 15-20%



for a total development cost increase of 80-90% since 1971. The report further pointed out that the production unit cost of the common version of the MRCA had also increased since 1971 on the order of 52%, and requested that the Defense Ministry reassess its solely funded Air Defense Variant (ADV) of the MRCA, in light of program costs.[104]

The first flight of prototype No. 1 was postponed several times. This slippage resulted from a series of failures during testing of the engine. A first major failure occurred during a 1972 bench test, a second in mid-1973 while being flown subsonically on a converted Vulcan bomber, and a third during a bench-test in December, 1973.[105] By 1974, amidst growing public skepticism, the plane was increasingly receiving labels from its critics such as "Europe's White Elephant" and the "Budget Wrecker".

As of February 1974, because of the resulting delay this caused in the program, Panavia had yet to exercise authority granted almost a year earlier to proceed with the production investment stage, with no major contracts for long-lead production items having been let as of that time.[106]

Uncertainty over the status of the engine led around this time to a Rolls-Royce offer to Turbo Union of the Anglo-French M53 (the surviving element of the AFVG fighter project) as a substitute engine candidate for MRCA. For their part, German defense ministry officials accelerated informal inquiries on possible replacement of the RB.199 with the G.E. J-101.

Ultimately though, corrective measures on the RB.199 were accomplished, and prototype No. 1 flew in August 1974 some 1-1/2 years later than originally scheduled.[107] Early the following year, in 1975, there was further slippage on the scheduled date of the first flight of prototype No. 3 because of late delivery of engines following a labor dispute at Rolls-Royce.[108]

(b) The First Two Production Contracts are signed (1976-77)

In July 1976 the production agreement was signed by the three nations, and NAMMA awarded a contract for an initial batch of 40 Tornados in its Interdiction/Strike version to Panavia. Shortly afterwards, an agreement was signed covering the manufacture of the first three prototypes of the UK's Air Defense Variant. A contract for a second production batch of 110 IDS aircraft was signed in May, 1977. As of this time some 70% of the production sub-contracts had been signed.

Of the initial batch of 40 aircraft, 17 were for the Luftwaffe and 23 for the Royal Air Force, mainly for training and conversion purposes. At this time, deliveries were scheduled from mid-1979 onwards. Italy was unable to order any aircraft from the initial production batch due to funding difficulties.

The reason for this was that the Italian parliament only passed the Aviation Bill, which mainly concerned Tornado production, on January 13, 1977, and therefore the Senate was not in a position to approve funding for the manufacture of the production aircraft. Nonetheless, Italy has contracted for 15 aircraft from the second MRCA production order.

(c) Modifications Following Developmental Flight Tests Cause Further Delays.

In the summer of 1978 NAMMA decided to accept delay in the delivery of the first production Tornado aircraft in order to permit modifications to equipment and subsystems to be incorporated immediately on the factory floor into initial production aircraft already under assembly. The changes stemmed from development flight test work. The alternative would have entailed delivering the planes in the unmodified state, while then, at some future date, having to return to the manufacturing site for modification. This meant that delivery of the first production aircraft was pushed back from mid-1979 to early 1980.

A factor complicating this work, is that the majority of these modifications affected systems and equipment installed in the forward fuselage section of the Tornado. Not all of the forward fuselage sections built at the British Aerospace Warton Division are assembled into aircraft there, some are sent to Manching to go into the German final assembly line. This caused the production program to lose some of the flexibility it would normally have had if it were all in one factory, since each forward fuselage section had to be complete before it could be shipped. If it were to be joined to the center and rear sections in the same factory, the work order could be rearranged to permit some of the installations to be done after assembly of the entire fuselage.

Yet another complicating factor was introduced by the fact that several different versions of the aircraft were represented in the first batch of 40 production aircraft, besides the dual-control models for the RAF and Luftwaffe training programs, it also included the first IDS (Interdiction/Strike) aircraft

for the German Navy. All of these have critical differences between their individual equipment, and consequently the modifications could not be 'slotted-in' identically on all three final assembly lines. The dense packing of systems and equipment in the Tornado's forward fuselage did nothing to make it easier to introduce changes at this stage.[109]

The net result is that a bottleneck was laterally created in Tornado production at the Warton plant. Again, this situation was not made any better by the fact that the same facility was simultaneously manufacturing Jaguars for the British, French and Indian Air Forces, as well as continuing to refurbish Canberras for various export customers. Moreover, since the Italian and German manufacturers were still keeping to their production schedule for those Tornado assemblies assigned to them, they found themselves in an 'overproduction' situation. The British were trying to persuade their partners to slow down their output rates correspondingly, but it appeared unlikely that their appeal would be heeded.[110] In 1979 the bottleneck in the UK was further exacerbated by yet another series of strikes by the British labor unions, that threw the program off by several more months.

Tornado production for the three nations is expected to continue over a 10 year period i.e., through the 1980's.

(d) Joint Training

The flight test-program is being carried out by joint military/industry test teams at the three Operational Test Centers: Manching (FRG); Caselle (Italy);





our trail in the sky



Aeritalia is known as the Panavia partner which has designed, developed and built the highly sophisticated wing sweep system for the TORNADO

It is not so well known perhaps, that Aeritalia has also participated in the development of the aircraft in the areas of structures, aerodynamics, flight mechanics, flight controls, subsystems and avionics.

Furthermore, Aeritalia is responsible for: *integration of national fits, antenna testing, fuel system testing, national avionics rig, national OTC training rig, development and production of supersonic tanks and radome, ordnance and external stores testing, commercial and technical development of several general and avionic equipments of both Italian and foreign manufacture.* In addition Aeritalia is involved in: *ground testing, flight simulation, flight testing of prototypes and pre-series aircraft, in the areas of handling, manoeuvrability, and flutter.*

All the above can be summarized by a simple figure: 100 "Tornados" built by Aeritalia in its capacity as prime contractor for the Italian Air Force.
An impressive qualification of a leading European aerospace company.

AERITALIA

80125 Napoli, Piazzale Tecchio 51 Tel. 619.522 - Telex 71370 (AERIT

and Boscombe Down (UK). Manching, FRG is also the location of the tri-national Service Instructor Aircrew Training (SIAT) Unit, where future instructors are becoming familiarized with the Tornado.

The delivery of first production aircraft to the SIAT Unit at Manching occurred in early 1980, some six months later than the time table originally envisaged.

Familiarization of three nations' instructors with the system at Manching in the FRG was carried out by MBB under contract from Panavia. The flight training program began in July, 1980 and was completed at the end of November.

The first flight crews from all three countries were to start their conversion training in May, 1981, at the Tri-national Tornado Training Establishment (TTTE) at the former RAF station of Cottesmore, in the UK. As of the end of November, 1980, eight of the 24 production aircraft delivered to the user services had been assigned to the TTTE.

The decision to go ahead with the joint training program had been taken back in 1975 after a joint operational training study group advised that a unified program would be more economical and would lead to an interchange of experience between the various air forces. As part of the program development, a joint trinational military group set up the training unit at Cottesmore. The group defined the training requirements and developed a syllabus for the aircraft, with necessary training aids and course documentation.[111]

Establishment of the common training program had to overcome differences between the three air forces and the German navy requirements. Each air force has its own peculiarities, and aircraft in the common pool have national variations in their equipment. Thus, the flight manuals and aircrew checklists require cross-references and supplements to insure that all requirements are met.[112]

The Cottesmore program consists of an operational conversion unit with three flight squadrons, a standardization squadron and a simulator and theoretical training squadron. The trinational training unit will be headed by a chief instructor—the post to be filled alternately by an RAF wing commander and a German lieutenant colonel.[113]

Additional rotational assignments to be filled by officers from all three nations include the air plans officer, commanders of the standardization and simulator squadrons and the navigational leader. To insure equal national control, other posts will be filled by one nationality, including the three flight squadrons to be headed by a German, British or Italian officer. However, each national head will have a navigator as deputy from another country, and the entire teaching staff of 12 pilots and three navigators will comprise officers from all three nations.[114]

Plans call for 300 pilots and navigators or 150 crews to be trained in 15 courses by the staff. About half of the crews will be German because the RAF's air defense aircraft crews will be trained elsewhere.[115]

(e) Marketing

Panavia efforts to market the Tornado outside of the consortium, have been as of early 1981, unsuccessful. The two major targets to date have been Canada (having dropped out of the development consortium after a few months in 1968) and Australia, both having been offered elaborate industrial offset packages covering production of some components, and final assembly under license as well as other defense and aerospace business external to the Tornado. Both countries, however, narrowed the final selection down to a choice between the F-16 and F-18.[116] A third major target, the USAF's Enhanced Tactical Fighter (ETF) program competition has yet to reach the stage of being a firm requirement.

In the spring of 1980 Panavia announced that the MRCA might in the future be offered for export purposes in a stripped-down version. The aim was to reduce multi-purpose requirements and costs in an effort to expand its market potential. Panavia felt that there was significant market for the airplane, especially in the latter half of the 80s.

The main problem was that the multirole day-night all-weather combat capability of the aircraft boosts the unit price and increases ground support and maintenance requirements.[117]

(f) The Air Defense Variant

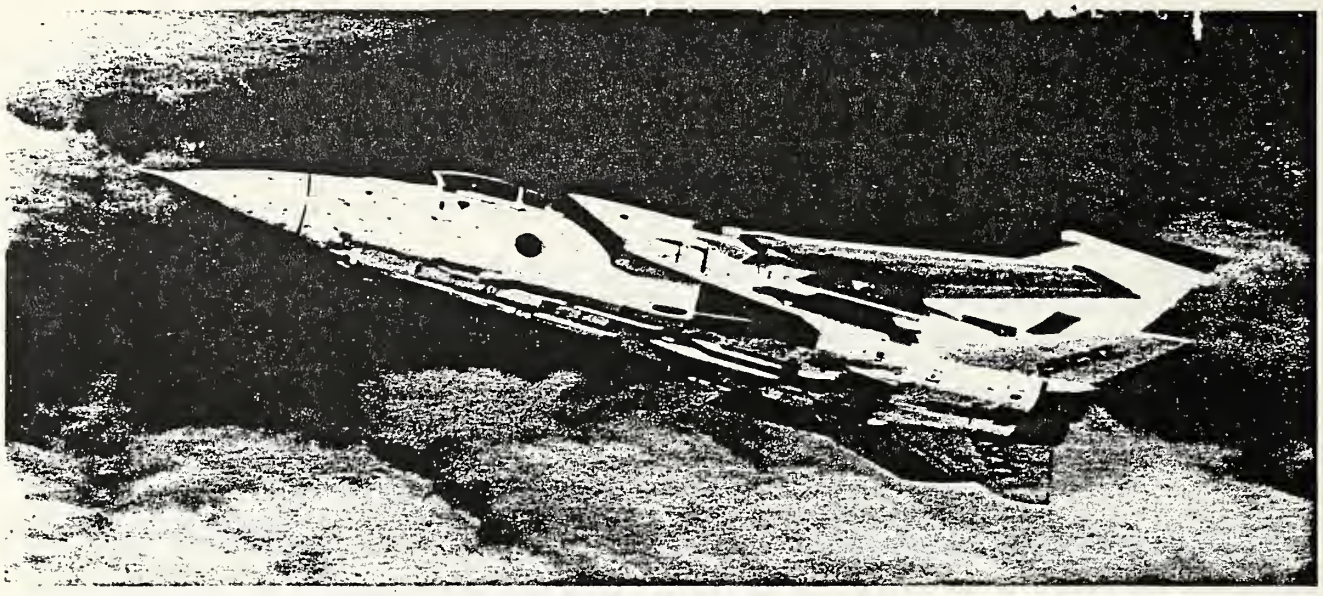
The MRCA Tornado comes in two principal versions: The Interdictor/Strike Version (IDS) which was first delivered in early 1980, 212 being for the

Luftwaffe, 112 for the German Navy, 100 for the Italian Air Force, and 220 for the RAF; and the Air Defense Variant (ADV), with first delivery scheduled for 1984 to the RAF, totaling 165 aircraft. The ADV version (called the Tornado F.2 by the RAF) will have 80% commonality with the standard (IDS) Tornado, and will be 25% more costly than the IDS version. The first prototype of the ADV, A.01, flew in October 1979.

Major differences between the IDS and the more expensive ADV version of the Tornado include the ADV having extra length (and therefore greater supersonic acceleration), a special radar, and increased fuel capacity. The aircraft itself, with two crewmen to share the workload in a heavy ECM environment, is designed to operate 400 miles from its base for two hours, including ten minutes of combat, without aerial refueling.

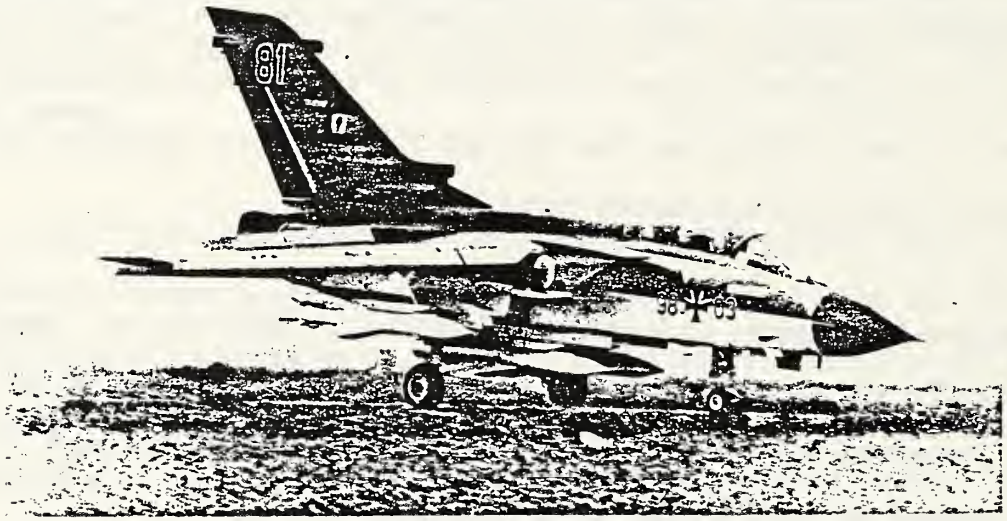
ADV features the Marconi Foxhunter track-while-scan radar that is capable of handling multiple targets simultaneously at ranges of more than 100 nm. Its Skyflash missiles will be able to hit targets at ranges of more than 25 nm, at high altitudes or at levels as low as 250 feet.[118]

In late 1979 the new British government briefly considered a possible cancellation of the ADV, and its replacement by either the F-14 or F-15, as part of a deal with the U.S., one tied to the U.S. offsetting this by its ordering the interdiction/strike version of the Tornado for the USAF. Nothing ever materialized, however, from this initiative.[119]

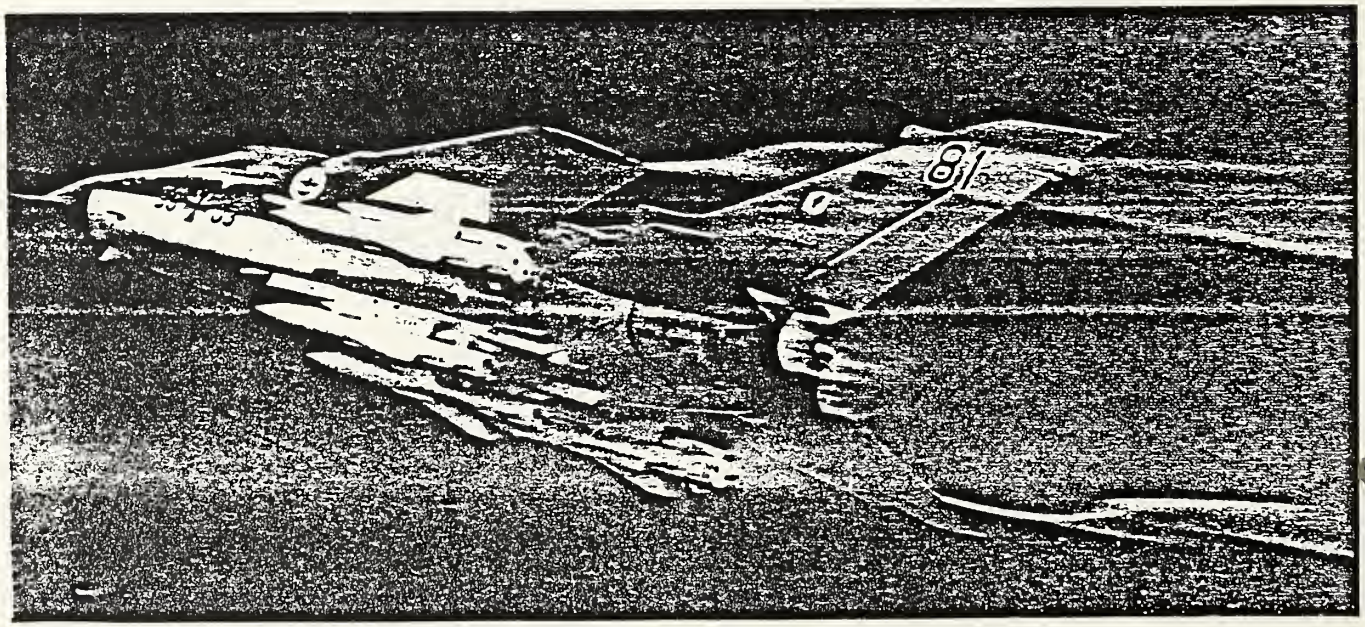


Second Tornado Air Defense Version Enters Flight Test

Second of three planned Panavia Tornado F.2 air defense versions of the multirole combat aircraft entered the flight test program recently at British Aerospace Corp.'s facility at Warton, England. First of the three F.2 prototypes has flown for more than 61 hr. and is undergoing handling and flutter tests. The second F.2 prototype will be used for weapons system integration and development.



Assis... sur ses freins, toutes traînées sorties un Tornado utilise son inversion de jet intégrée à l'atterrissage (ATPAA).



MRCA Tornado is one of the elements which will enhance NATO's conventional capability.

6. NAMMA

The NATO MRCA Management Organization's (NAMMO) instructions are carried out by NAMMA, the agency which functions as NAMMO's executive arm. NAMMA, by 1972, had a staff of 220 located in Munich. The contract structure during development was one based on a single line of authority starting with NAMMA, through Panavia GmbH, as prime contractor, and two associate contractors Turbo-Union Ltd. and IWKA/Mauser.[120] As trinational prime contractor, Panavia, in cooperation with the NATO MRCA Management Agency (NAMMA), has design responsibility for the Tornado and directs the total program, which includes almost 500 companies. The work of national subcontractors and the procurement of equipment in each of three countries is handled for Panavia by its three main subcontractors (and co-owners), acting as Panavia's agents, and subjected to ratification by NAMMA selective committees.[121]

The employees of NAMMA are designated by the three governments. The number of individuals on NAMMA's staff representing each country are in proportion to their participation ratios in the total program.[122]

The General Manager has no influence in the selection of the personnel serving under him. Consequently, General Kruger, NAMMA's second General Manager, saw in his position a very essential requirement, in that "the loyalties of the personnel from the three countries become directed toward the program, rather than giving priority to various national interests." To fulfill the neutral supervisory function, he felt is was necessary to establish a corresponding working climate within the international working staff.[123]

NAMMA was divided into six Divisions during the development phase, (roughly corresponding to the primary divisions of Panavia at that time). These are:

- Plans and Programmes;
- Military Factors;
- Systems Engineering;
- Manufacturing and Quality Assurance;
- Budgets and Contracts, and;
- Administration and Personnel.

These divisions are staffed with the correspondingly trained personnel. These encompass technicians and engineers, and also lawyers for interpreting the governmental agreements and individual national rights within the Agreement. In addition, the duties of NAMMA include the supervision and investigation of price structures, regional differences, business conditions, overall economic conditions, inflationary trends, price situation of the world material market, and price proposals from industry.[124]

A significant number of military officers from the three nations were also delegated to NAMMA during development to ascertain that the military requirements were being met, and to periodically verify the appropriateness of the ordered outfitting.[125]

NAMMA was the seat of approximately fifty technical working groups during development which provided guidelines to industry in attempting to reconcile the fact that there was no common description of the system applicable to the four MRCA user armed forces, while the necessity remained to investigate operational utility by following a total system approach with consideration to the individual system components (e.g., the aircraft, its outfitting, ground service and personnel, logistics, supply, repairs, reliability, material storage, replacement parts inventory, interchangeability). Among these groups were price examination, weapon-carriage, flight-test program logistical systems, training of ground service personnel, and development/growth.[126]

Considering all the above, the General Manager of NAMMA was responsible for the preparation for all steps that needed to be taken at a given time, while pressing to ascertain that the divergant political, economic, and technological goals remained consistent with the military requirements.[127]

To keep the program under tight surveillance during development with respect to performance, costs, and schedule, the NAMMA General Manager had three technical means at his disposal, encompassing PERT techniques, computerization, EDV, and schedule/event presentations. These means are:

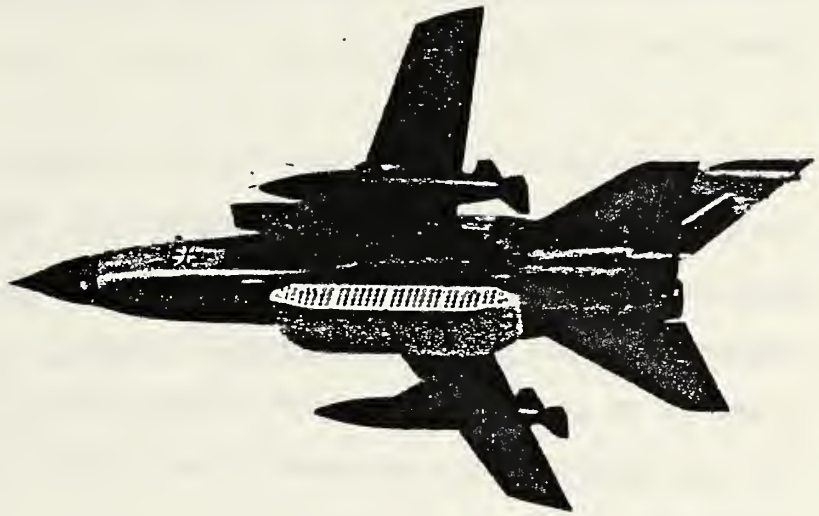
- Program Management System;
- Review and Authorization Procedure, and;
- Configuration and Control Procedure.

With the introduction of the special MRCA Program Management System (PMS), the contractors had at their disposal a centralized planning, directing and controlling organization.[128]

As the contract-letting agency, NAMMA, exercised control over as many as 1500 subcontracts. The Program Management System had the function of ascertaining, during development, that the contract-letting agency need not deal with numerous firms, but on a direct counterpart basis only with the three primary contractors: Panavia, Turbo-Union, and IWKA/Mauser. The coordination of the work efforts of the lead-firms is controlled contractually. A special information system monitored by the contracting agency was intended to make transparent the progress of the program, as well as the inevitable technical changes, while ensuring that the information is automatically passed on to all those who required it.[129]

The following examples were given in the 1972 Wehr und Wirtschaft article to demonstrate the high level of integration within the MRCA program and the cost effectiveness of the Program Management System.

1) A computerized central net plan, into which appropriate net plan data was constantly being supplied by the partner firms within Panavia and Turbo-Union. The central net plan contained all the significant program milestones on the government and industry levels. It was intended that through







Panavia Tornado preproduction aircraft are carrying a variety of external loads as part of the continuing flight test program. These loads include external fuel tanks and electronic countermeasures (ECM) pods (opposite page, above) and in the formation photo on this page, the MW1 multipurpose weapon and external fuel tanks (top), a combined bomb load with external fuel tanks and ECM pods (center) and two Messerschmitt-Boelkow-Blohm Kormoran antiship missiles plus external fuel tanks (bottom). A Panavia Tornado will be displayed at the Hanover air show.

this plan the technical, financial, and scheduling inter-relationships and how they relate to the achievement of the milestones, would be made clear.

2) Regular meetings of the three Configuration Management Boards would guarantee that those represented on these boards (i.e., Panavia, the Panavia partner firms and NAMMO) could each indicate what changes had become necessary on individual items or on the total system. In this way the impact of changes in single items on inter-related ones could be taken immediately into consideration. The occurrence of an isolated "special development" thus being avoided.

3) A common Data Management System - binding for Panavia, the Panavia partner firms, and NAMMA - was to guarantee a standardization and normalization of the information flow. This applied from the usual program technical terms up to the format and preparation of individual letters. A special coding and storage system would automatically guarantee punctual replies to inquiries, or for example, the timely delivery of required planning and technical documents to the customers.

4) A centralized End-Product Management directed the MRCA production in the three partner countries with the help of a special production net plan.

5) A centralized control system had at its objective assuring that production quality meets the required NATO standards.

6) Rapid and effective information flow was guaranteed by maintaining direct air connections between the development and production centers, a common telegraph code for exchange of technical information, and other arrangements.[130]

With its organization, the program language (English), and the work location of Panavia and NAMMA all in common, the General Manager of NAMMA felt that the three primary requirements of a modern international management system would be fulfilled, namely:

1) rapid and reliable flow of information;
2) rapid decision making, and;
3) optimum division of the work effort/work delegation.[131]

Two of NAMMA's biggest challenges involved: equipment selection negotiations with the four services that were to operate the aircraft, and reaching an agreement on mutually acceptable work-sharing allocations. NAMMA's handling of negotiations with the four services over equipment selection proved to be a much more time consuming process than had been envisaged at the outset - particularly with regards to avionics.

Coming up with a mutually acceptable division of developmental and production work was another thorny problem. This task called for continuous attempts at reconciling the demands of the six parties; the three governments and the three Panavia partner firms. Once the division of responsibility for the major components of the system had been worked up between the three national main

subcontractors, these three and Panavia established a host of specifications, tenders had to be invited on a tri-national basis (which also proved to be a particularly time consuming operation), and finally all the separate systems and equipment items had to be submitted to NAMMA for its final decision.

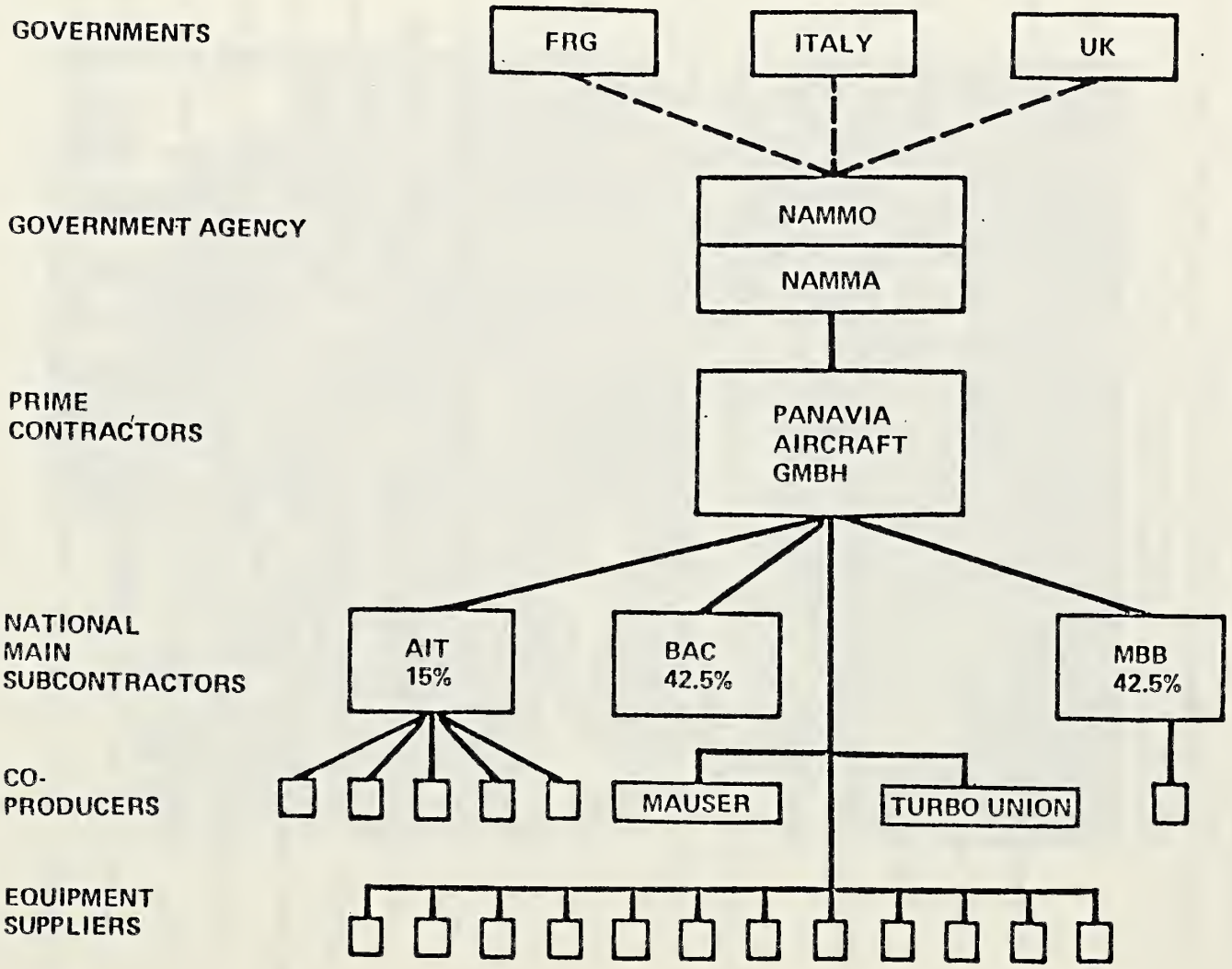
As an example of the number, scope, and complexity of inter-governmental MOU's required in such an integrated project effort, MOU 7 covered the continuation of development and manufacture of prototypes and engines, manufacture of spares for the industrial flight trials, the flight trials proper, simulator development, continued component testing, definition and procurement of ground servicing and checkout equipment, design work on training equipment and fatigue testing. MOU 8 covered the manufacture of pre-series aircraft and preparations for production start up, while MOU 9 involves procurement of long-lead items for production aircraft.

The FRG's obligations alone under each of these MOU's were DM 518 million for MOU 7, DM 342.36 million for MOU 8, and DM 265 million under MOU 9. If the program is cancelled, the three memoranda contain clauses that permit cancellation without compensating the partners' costs, each government only covering financial liabilities with its national firms.

7. Panavia GmbH

As regards its legal form Panavia is a German Gesellschaft mit beschraenkter Haftung (GmbH), i.e. a privately held company. From the standpoint of its

MRCA Tornado (Production)

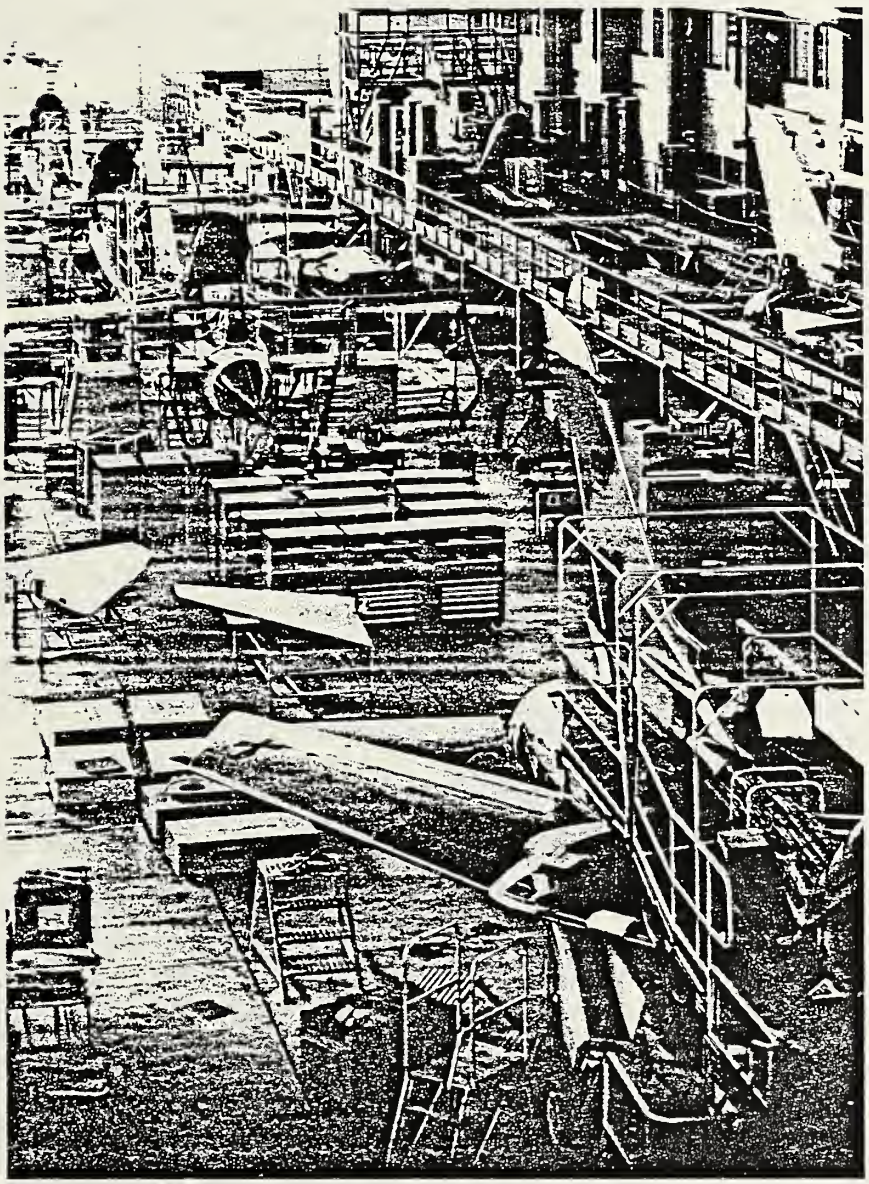


structure and terms of reference, it deems itself to be a tri-national European enterprise.

The structure of Panavia is quite different from that of such shell companies as SEPECAT set up for the Jaguar program, SECBAT for the Atlantic program, or SETEL for the Hawk Program in that it is a fully operational company. Though the original tri-national initiative resulted from a governmental decision, the specific organizational form of industrial program management was proposed by the three designated main contractors. As of 1972 Panavia had a resident staff in Munich of 145, having below the Board of Directors, a full-time managing director and functional directors for each of the main activities - design, sales, finance, production, and so forth. As of 1977 Panavia's staff was somewhat over 200.

From the beginning of the development phase, Panavia has been the prime contractor for the development and construction of the aircraft; with its co-owner companies, Aeritalia, British Aerospace and MBB, in the three participating countries, as national main subcontractors. Since 1977, Panavia has also assumed the role of the prime contractor for the entire weapon system, including the engine and gun, and it also is responsible for the trinational coordination, and control of logistic and technical support during the in-service phase.[132]

In order to overcome the difficulty of dealing with three national companies and four services in delivering the aircraft, Panavia not only contracts for development of the aircraft, but also for all other equipment and special rigs. Thus, while most of the work is delegated to other companies, the



Final assembly of the Panavia Tornado is under way for 324 aircraft ordered by the German air force and navy at the Messerschmitt-Boelkow-Blohm facility at Manching. About 40% of the Tornado's components and parts are supplied by West German firms. The aircraft production rate is scheduled to peak at about 12 a month.

Aviati

contract remains central.[133] The 3 national main subcontractors serve as Panavia's agents in placing the contracts for all components and equipment. All developmental and production contracts are reportedly fixed price and "are sometimes adjusted downwards, but never up, unless the customer revises his requirement."

As pointed out by Dr. C. P. Fichtmueller, Managing Director of Panavia since February 1979, in an interview with Military Technology and Economics in late 1979,

> None of the TORNADO partners was a newcomer to international cooperation. The structure of Panavia, a fairly small central team based in Munich for steering the activities of the working teams in the partner firms, represents a splendid compromise derived from the experience gathered by the industries of the participating nations from international combat aircraft programs. We here in Germany, engaged as we were in the German-American AVS combat aircraft project, set up a tightly run system of program organization with fully integrated teams, based in regard to the government side of the operation in Dayton, Ohio and in regard to the industrial side (EWR Fairchild Joint Venture) here in the same building in Arabellastrasse, Munich. This organization was stamped by the philosophy of the American main contractor. The British and the French maintained a relatively informal kind of cooperation on a committee basis for programs such as JAGUAR or the AFVG. The Italians had collected their experience from the international G-91 program. All these programs were, to a certain extent, on the path leading to the establishment of Panavia. In line with the wishes of the governments concerned, the partner companies also endeavored to avoid the weaknesses of former cooperative schemes and to build up an efficient organization. By and large, this organization is still largely valid today even though the priorities in the work have shifted hand in hand with the progress made on the development of the aircraft.[134]

Panavia GmbH work and cost sharing formulae among the three national industries for the development phase of the IDS version were:

	Work Sharing[135]	Cost Sharing
UK	42.5%	44.5%
FRG	42.5%	44.5%
Italy	15%	11%

The developmental formula for Turbo Union Ltd. was:

Rolls-Royce	40%	40%
Motoren and Turbinen Union	40%	40%
Fiat	20%	20%

The production formula for both cost and work sharing is in line with national requirements:

UK	47.64%
FRG	40%
Italy	12.36%

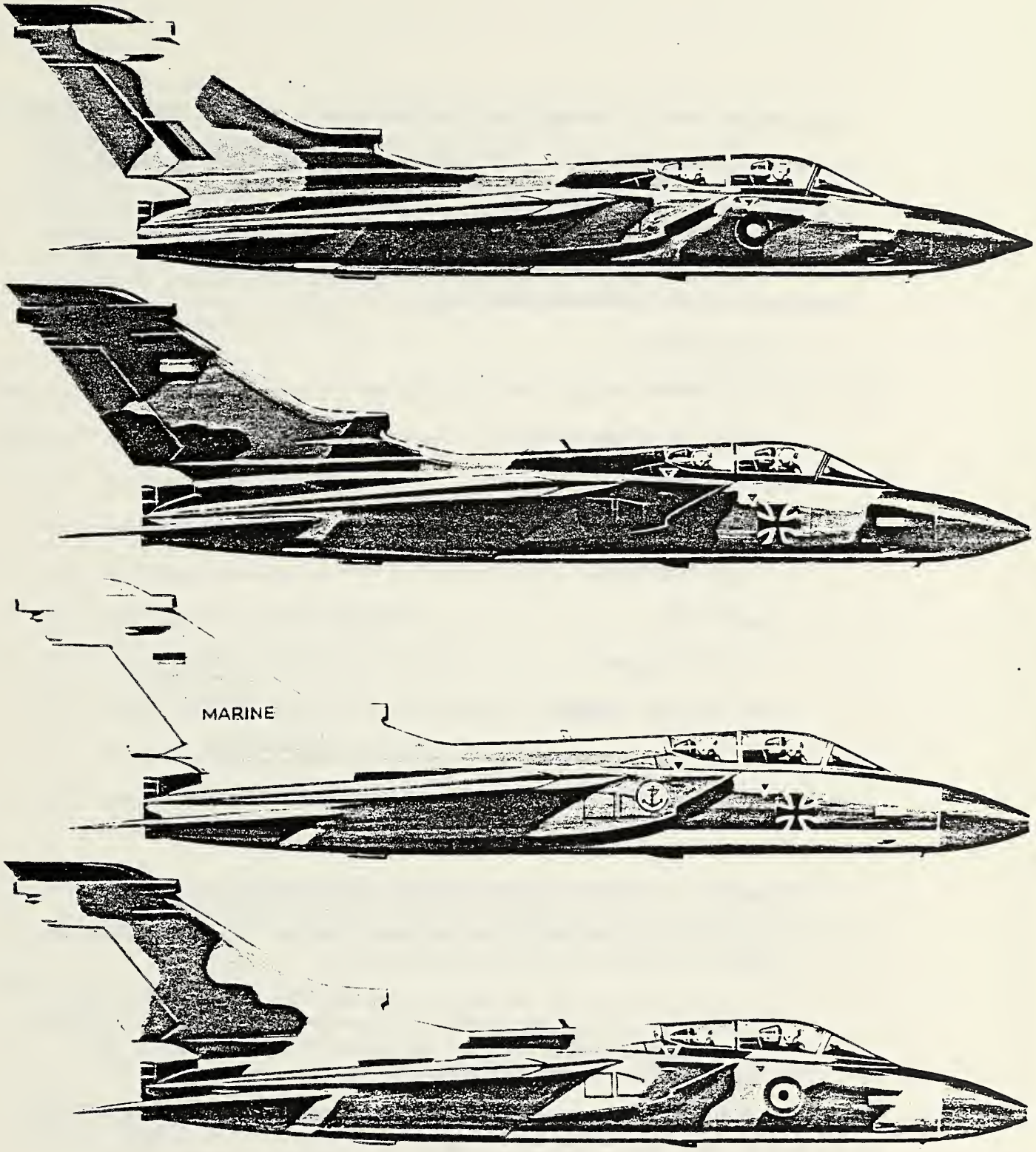
The airframe and equipment represented 35% of the total contract value, avionics represented 37% and the engines 28%.

Although manufacturing is sole source, each nation has its own assembly line for its own version(s) of the aircraft.

In the 1979 Miltech interview, Panavia's General Manager, Dr. Fichtmueller explained how the current ownership shares in Panavia of the three main national subcontractors had come to be, as well as several related issues:

> Roughly speaking, the shares in the company are accorded with the probable degree of participation by the partner firms in the program and that in turn depended on the given scale of governmental participation, i.e. the number of aircraft to be ordered by each state. Right at the beginning, the German requirement stood much higher than that of all the other nations together, a fact which was reflected in MBB's 50% share of Panavia. Following the withdrawal of the Dutch in 1970, there came the first and only redistribution of shares with British Aerospace and MBB accounting for 42.5% each and Aeritalia for 15%. At the time, this solution represented something of an approximation and it has remained so until now. While the German requirement formerly exceeded that of the British, the position today is the reverse. The British will receive about 47% of all aircraft, the Germans 40%, and the Italians 13%.
>
> The purpose of the structure given to an international management must consist in achieving a balanced spread of the stresses produced by cooperation. To that extent, the percentages of participation and the views of the various partners clearly have a role to play. The location of the company in Munich should also be seen in this context as a quid pro quid for the acceptance of English as the sole programs language. For me, this step fulfills a basic condition for an efficient joint program. Translations pose a grave handicap to communication in the daily work of an organization. The acceptance of English— which is also the language of aviation—has naturally meant that the Germans and Italians were forced to learn a lot of English. Although working in a foreign language has gone down very well, it nevertheless constitutes an additional burden. From the German standpoint, it virtually represents a factor with which to offset the higher travel expenses incurred by the British.[136]

The project management system adopted is somewhat complicated, but no other solution was found to provide a joint working basis combining the quite different commercial laws of the three nations and to coordinate the just as different requirements of their air forces. It was often stated that another type of management system might have considerably lowered the cost of the whole program, but the initially nationalistic tendencies of the three nations and firms had to be catered to in order to just get the project off the ground.[137] Twelve years later—the management organization created for Panavia has proved to be a very efficient solution to international collaboration on a



PANAVIA

Panavia Aircraft GmbH München, Arabellastrasse 16, Germany

AERITALIA BRITISH AIRCRAFT CORPORATI

PVA 30

large scale, and has evolved into what has become another important model for current and future European joint development programs—such as the Anti-Surface Ship Missile (ASSM).

There are currently directorates for:

- development;
- production;
- commercial interests;
- procurement;
- planning;
- flight testing;
- marketing;
- product support;
- Air Defense Variant;

Fichtmueller had this to say on the subject of structure:

> Panavia's structure is not particularly hierarchical, being influenced by its function of steering the TORNADO program. Accordingly, it reflects the customary pattern of organization in industries such as aviation and aerospace.
>
> In my view, this wide diversification and the concomitantly less hierarchical set-up are typical of a program organization marked by a 'governmental character' and entrusted with integrating the various aspects of program work.[138]
>
> Panavia should be seen as the point of integration for the efforts undertaken by our partner firms in carrying out the TORNADO program as an individual consortium.[139]
>
> Panavia is the steering organization for the whole range of industrial activities embraced by the TORNADO program. In the field of management, it has quite deliberately focused overall integration and control so as to leave as many functions as possible decentralized. The whole range of activities involved in

> development, production, and logistics are handled by the partner firms or else by subcontractors subject to the control of the partner firms. The terms of reference of the consortium represented by Panavia encompass all activities peculiar to the development phase and to logistics (with the exception of the engine) and to the production phase including the engine. As regards weapons, we are responsible for their integration into the overall system with the gun being treated like the engine since it is fitted into the aircraft. There is virtually no government furnished equipment in the series production.[140]

Panavia's Program Management System provided the program leadership with eight essential working tools and decision-making aids:

1) Statements of Work;
2) Work Breakdown Structure;
3) An Integrated System for following Costs and Schedules;
4) Centralized Program Control;
5) Configuration Management System;
6) Specifications for the Total Weapons System;
7) Data Management System, and;
8) Documentation of the Technical Progress.

Panavia officials have emphasized that the key to successful achievement of the program was a total reliance on standardization. Emphasis on standardization is seen in:

- single project language (English) and weights and measures (metric);
- uniform standards of evaluation for aircraft and equipment, and also for flight clearance;
- uniform standards of production supervision;
- practical standards of cost accounting in all participating

countries, compatible with practices laid down by the laws of each country;

- standardization of sub-contract agreements, and also of legal procedures, taking particular national requirements into account, to permit smooth international commercial cooperation;
- common procedures for total workload sharing in Statements of Work and work packages. In addition, these procedures will be used for proportional work-sharing between the three countries involved;
- Panavia design standards handbook, unified drawing standards and processes for computer-aided design;
- standardized procurement and test procedures, with common requirements for all suppliers;
- component interchangeability with the use of master reference tools;
- standardized procedures for design changes and configuration control.[141]

The Alpha Jet provides us with an example of a project where standardization was not worked out on a mutually agreed to ad hoc basis, but instead by reliance on one nation's specifications, standards and practices; those of France in the case of the Alpha Jet.

8. Work Sharing - The Three National Main Subcontractors and Panavia

In the interest of cost effectiveness, each of the national main subcontractors (BAe, MBB, and Aertlalia) manufactures specific major

components of the Tornado airframe for all prototype, pre-series and production aircraft:

- BAe is manufacturing the complete forward fuselage and the rear sections, including the empennage;
- MBB is responsible for the fuselage center section;
- Aeritalia for the wings.

These major components are interchanged between facilities by road (air freight proved to be too expensive a proposition) for final assembly in the plants of the three national main subcontractors for each of their respective national services, i.e., each produces 809 major components but delivers only that number of aircraft ordered by its own government. The three contractors fully equip the aircraft they assemble, and carry out the pre-delivery proving flights.

In line with the degree of integration achieved within each national aerospace industry the structure of the national work packages vary widely. At one extreme there is the case of BAe where the manufacture of the UK's assigned air frame share is almost completely carried out within the company's own facilities at Warton, Preston, and Samlesbury. In the middle is the FRG where the majority of the work is carried out at MBB, primarily the plant in Augsburg but also at Donauworth (both in Bavaria), and with one leading subcontractor VFW also sharing in the German portion (35%). VFW's facilities are located in Bremen and Varel (Lower Saxony). At the other end of the range lies Italy, where the manufacturing effort is highly fractionated, being divided up by Aeritalia among a large number of subcontractors. To develop the



Under the curtain

TORNADO NATO'S No1 in all weathers

VA44

PANAVIA

Panavia Aircraft GmbH, München, Arabellastrasse 16, Germany

AERITALIA

BRITISH AEROSPACE

MESSERSCHMITT-BÖLKOW-BLOHM

Tornado's unique combination of swing-wing configuration, 2-man crew, advanced avionics and unsurpassed handling characteristics enables it to strike powerfully and precisely beneath the curtain of radar and missile defences – in any terrain and any weather, by day or by night. Its navigation and weapon-aiming systems have the high precision needed to ensure accurate attacks against heavily defended moving or static targets, on land or at sea, in any weather conditions and in the most hostile ECM environment.

wing Aeritalia teamed with Macchi (underwing weapons pylons), Piaggio (wing leading edges and slats), SACA, now re-named IAM (flaps and actuators for the underwing weapons pylons), and SIA-Marchetti (wing tips and wing centre section fairing). This work-sharing is essentially the same for the production run with the addition of Aeronavali participation.

As for the level of investment required in each nation in obtaining up-to-date manufacturing equipment there is again considerable variance. First of all unlike in the FRG and the UK where practically all work is carried out within the companies own facilities, a different solution had to be found for the Italian work share. The inclusion in the work sharing program of practically all Italian airframe manufacturers had to be guaranteed and this affected even the detail design of the wing.

With the Italian work share divided up among such a large number of subcontractors advanced labour-saving production methods had to be discarded to some extent. In Italy, as in the UK, wage rates are much lower than in the FRG, which means that the work force employed in the former two countries tends to be larger.[142] The greatest amount of investment for the program in machine tools and equipment therefore occured in the FRG, especially at the MBB Augsburg plant (e.g., the election-beam welding system for the manufacture of the Tornado's titanium wing box, the largest of its type in Europe).

Compared with the brand-new manufacturing and assembly concept employed in the FRG, BAC in the UK is making use of available production technology and will, in general, only make slight modifications to existing methods in order to

keep down costs.[143] One of the main reasons for this is that compared with the fuselage centre section few of the components in the UK's share of the program are high-stress. They are therefore manufactured as a conventional shell structure rather than in an integrated form. In addition, the Royal Air Force will largely be responsible for the maintenance and overhaul work, which means that there is a much smaller workload on the industrial assembly line in the UK than in the FRG. Nevertheless, because of the multitude of parts and the new and highly-exacting quality parameters, heavy demands are being placed on the UK production line.[144]

Another point where differences exist involves assembly line methodology. The German assembly line at the MBB Manching facility is based on the transfer line principle, while British Aerospace in Warton uses other methods. Transfer assembly lines, in contrast to the usual stationary operation, function on a flow concept. Reportedly, German employees were more willing to adapt to a given work plan than is the case in the UK. On the other hand, British Aerospace has extensive experience from previous programs, which it has been able to incorporate into current Tornado final assembly methods.[145]

The number of man-hours planned for the production phase of the Tornado project has been held down to 100 million. The development phase had taken around 50 million man-hours, but it should be noted that a high percentage of this latter figure was concerned with series production planning and the streamlining of production methods.[146]

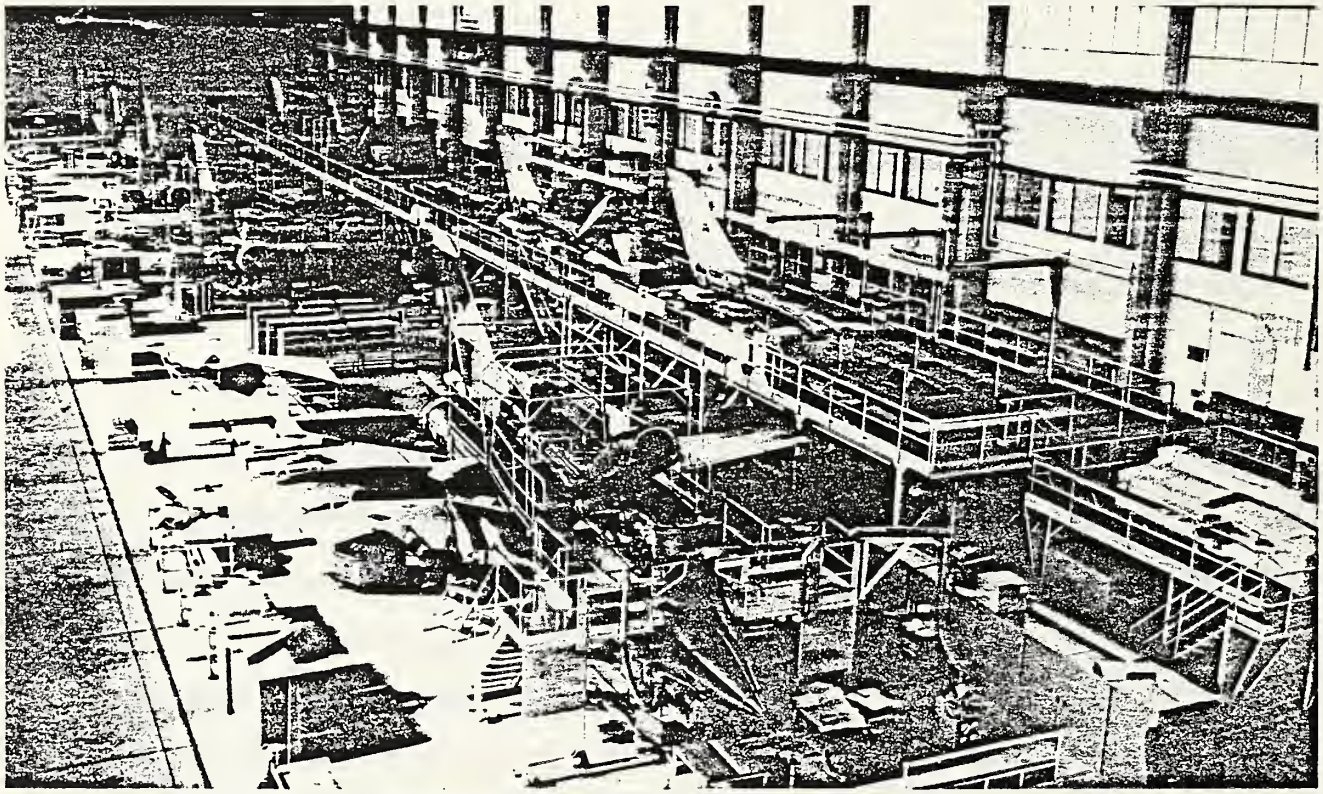
As one might deduce from the preceding description of Tornado work distribution, production planning for the entire Tornado program represented

one of the most complex undertakings ever attempted in Europe. This called for the delegation of exceptional responsibilities to the industrial coordinating organization, Panavia. Panavia's competence extends across all areas of production planning, procurement, program control and product support. The fact that each of the three leading aircraft companies involved, in the FRG, the UK and Italy, manufactures 809 main assemblies but delivers differing numbers of completed aircraft from its assembly lines, has done nothing to make Panavia's job easier.[147]

Timescale planning and material procurement planning are organized to ensure that all supplies reach the assembly line at precisely the right moment. The most important aspect of production control is ensuring the joint delivery, by all three manufacturers, of main structural components to the final assembly lines.

The Panavia management has had to take such conditioning factors as the differing assembly methods and capital-to-labor ratios into account and at the same time minimize the impact of program delays in one country on production in the other countries. This problem will play a significant part in the attempt to make up the current eight-month delay on the original schedule.[148]

For this reason, two of the most important Directorates of Panavia are Production and Procurement, and the success of the whole program depends on their close cooperation. The Production Director relies heavily on two divisional managers: Production Planning, and Manufacturing Coordination. While Production Planning is mainly concerned with programming and schedule control for



Tornado assembly line at Messerschmitt-Boelkow Blohm, Manching, where all aircraft for German air force and navy will be assembled.

main contractors and suppliers, the Manufacturing Coordination Division is primarily responsible for provision of manufacturing facilities.[149]

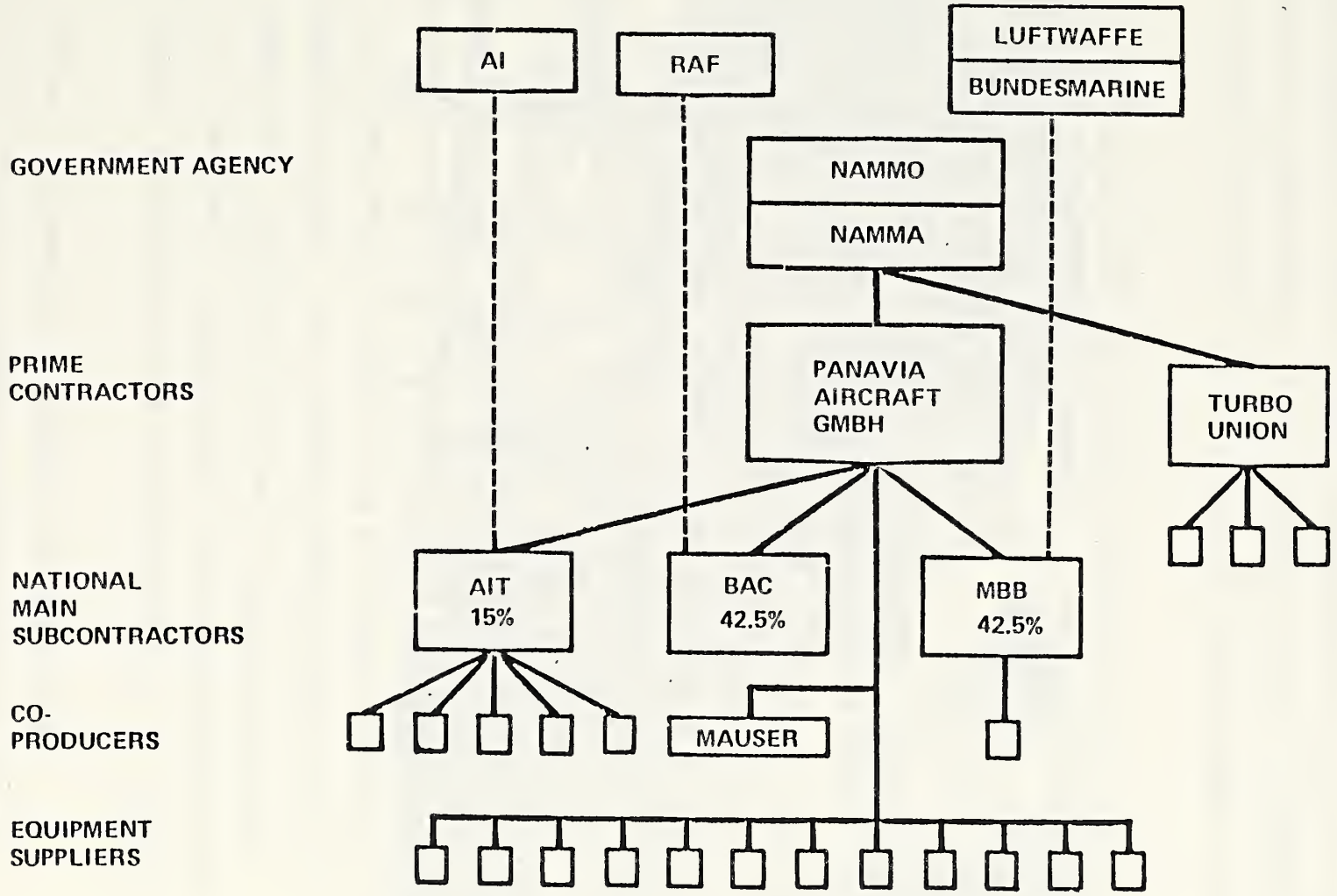
As prime contractor, Panavia also has the obligation to report on a detailed basis to all three governments. In this respect, thousands of program steps have to be supervised on a weekly or monthly basis, which makes this one of Panavia's principal activities. The large data processing center used has no equivalent in European industry. Integration of this massive information flow is an indispensable part of Panavia's role in ensuring the successful outcome of this complex project.[150]

9. Product Support

One novel feature of the program is the fact that the three governments turned over to a multi-national industrial organization a full range of responsibilities during the utilization phase. The spares for all three participing countries will be procured by a single management company, Panavia itself. Standardization criteria are being extended to common procedures for logistic support, including spares, preparation of technical publications, repair and overhaul. Common procedures are being utilized for identification, ordering and transporting, in concurrence with the NATO MRCA Management Agency (NAMMA) and the individual participating governments.

Panavia's responsibility extends to all activities including airframe, engine, gun, equipment and product support. Panavia chairman F.W. Page told Aviation Week & Space Technology, "I want to stress this because this is the first time that a truly multinational company anywhere has assumed prime contractorship

MRCA Tornado (Product Support)



for a complete aircraft weapons system and the overall program, extending to cover the operational life of the aircraft."[151]

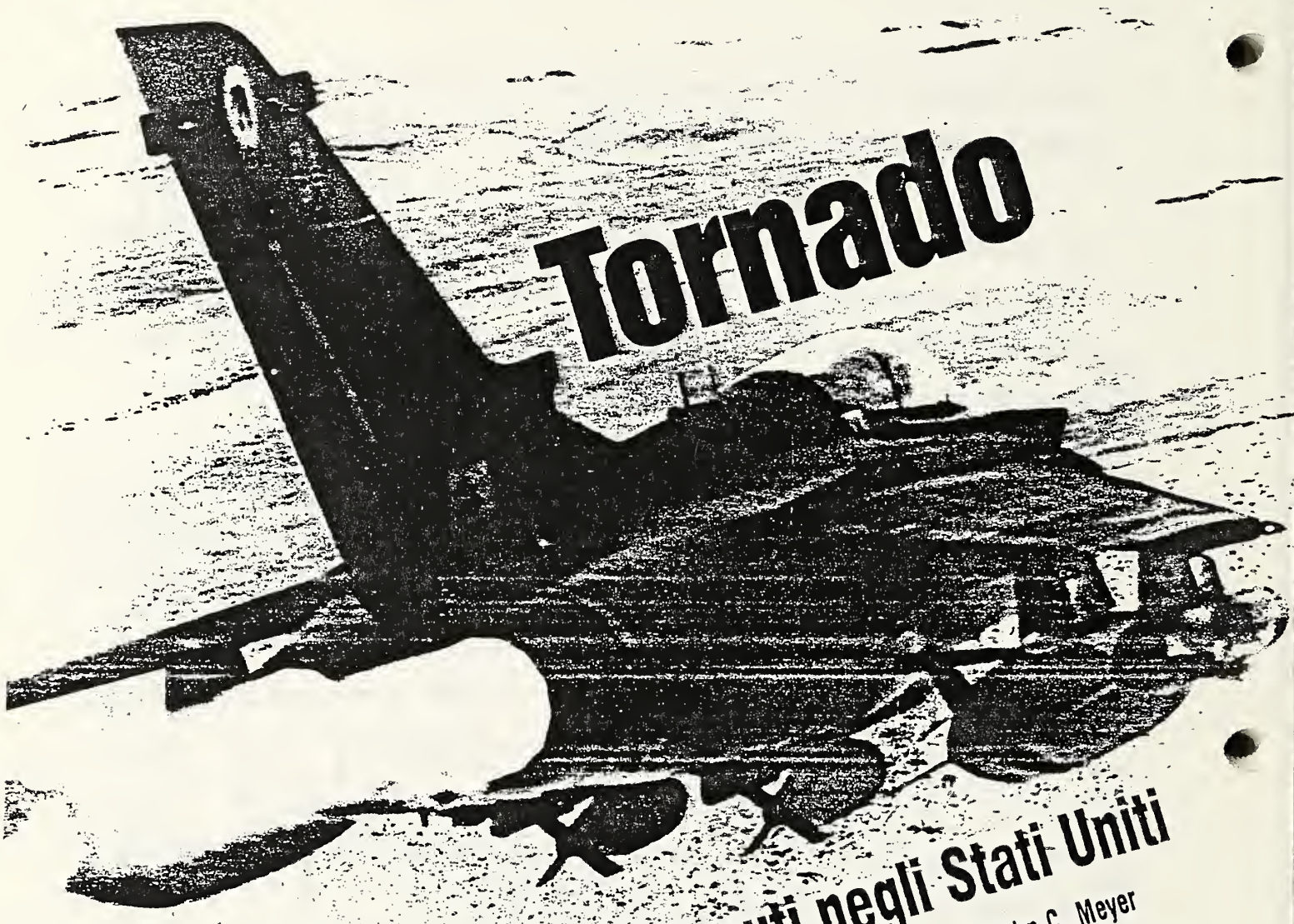
In product support, Panavia's approach is consistent with its overall company policy, i.e., not doing the work itself—since it would be pointless to pool the three countries' and four services' effort at one point—but by initiating, integrating and monitoring the implementation of the work of the three companies and suppliers.[152]

The partner company in each nation will be the direct technical contact for its own Air Force or Navy, and will provide support services directly on behalf of Panavia. On the other hand, Panavia will guarantee that the resources of all three companies are fully utilized to meet the requirements in support of the three nations.[153]

Product support, as with the overall Tornado program, is divided into three principal phases:

Program	Product Support
- development and testing	Phase A
- preparations for full scale manufacturing	Phase B
- series production	Phase C

Phase A, entailed the fulfillment of logistic requirements during the development period. In Phase A, the entire product-support program was defined and developed, at the same time as the overall support philosophy was being conceived.[154]



Tornado ripete i successi ottenuti negli Stati Uniti

Per il secondo anno consecutivo un bireattore da combattimento ogni tempo TORNADO appartenente alla RAF ha trionfato nelle gare di bombardamento organizzate dall'USAF negli Stati Uniti.
La RAF, che partecipava quest'anno con i TORNADO del 27ª Squadron, e in competizione con i B 52 e gli F 111 dell'USAF, ha conquistato la prima e la seconda posizione nei Trofei intitolati a John C. Meyer e a Le May, e il secondo posto nel Trofeo Mathis.
Questi brillanti risultati sono migliori di quelli ottenuti nel 1984.

La competizione rappresenta un severo banco di prova in ambiente elettronico ostile, per verificare il livello di addestramento raggiunto nelle operazioni di bombardamento ad alta e bassa quota.
Ciascuno dei 34 equipaggi ha effettuato due sortite diurne e una notturna, mentre ogni missione ha avuto la durata di oltre 6 ore coprendo distanze superiori a 2.400 miglia nautiche.

1° e 2° posto nel Trofeo John C. Meyer
per il miglior team di TORNADO F 111 (due equipaggi) per il più elevato punteggio raggiunto in 6 missioni d'attacco a bassa quota.

1° e 2° posto nel Trofeo Le May
per l'equipaggio di TORNADO, B 52 o F 111 che abbia ottenuto il più alto punteggio in 3 missioni d'attacco ad alta e bassa quota.

2° posto nel Trofeo Mathis
per il miglior team di TORNADO, B 52 o F 111 (due equipaggi) che abbia ottenuto il punteggio più elevato in 6 missioni d'attacco ad alta e bassa quota.

PANAVIA
Panavia Aircraft GmbH. Munchen. Arabellastrasse 16. Germany
MESSERSCHMITT-BOLKOW-BLOHM

AERITALIA BRITISH AEROSPACE

Phase B comprises the industrial measures taken to set up the supply and maintenance organization, and this will be completed around the end of 1980. The preparation of technical documentation, spare part selection and delivery scheduling, and selection and procurement of ground equipment, training, and the supply of instructional devices are covered in this phase, and a final task concerns 'configuration management', or the supervision and documentation of all modifications.[155]

Finally, in Phase C, the industry will contribute to maintaining the operational readiness of the Tornado in service. Phase C of the program will thus include technical development support, configuration management, technical-logistics assistance, customer service and contractor-supplied maintenance. Whereas the participating nations are working in integrated cooperation in Phase B, under the central coordination of the Panavia organization, the three countries will have to take national needs into account in Phase C, and each will, to some extent, go its own way.[156]

Phase C will mark the beginning of support tasks during the Tornado's operation-al life. After delivery to operational units, the manufacturers will retain responsibility for a range of tasks aimed at keeping the aircraft serviceable. Factory-provided maintenance is largely a matter for the German firms involved, since the military services in the Federal Republic — unlike those in Italy and the UK — leave maintenance work largely to industry.[157]

To illustrate the activities of NAMMA and Panavia under Phase B the February 1979 Interavia article entitled, "Product support for Tornado units - an

industry responsibility," used as an example the selection and procurement of ground equipment for operational units.

With the assistance of the military services, Panavia first set out the basic requirements of the equipment to be procured, then established performance parameters in order to evaluate the proposals offered by manufacturers in the three countries.[158] A preliminary step was to determine whether the same equipment was already in use with one of the participating services.

A special NAMMA committee, the Aerospace Ground Equipment (AGE) Panel was then set up to determine whether a common, tri-national purchasing procedure was feasible or if national procurement was to be preferred. The tri-national approach was adopted, and this led to an MRCA Aerospace Ground Equipment Data process which involves qualification testing of the chosen equipment, followed by compatibility tests and type approval.[159]

Experience gained with the selected system is then made available to the three countries, fed into the Panavia 'maintenance and repair data bank' and then used to establish maintenance requirements and, where necessary, the procurement rate for spare parts or complete units. In generating maintenance manuals/handbooks (or Technical Orders) a building block concept was adopted. Draft maintenance procedures are written up by the individual suppliers. Panavia collects these and passes them on to each nation's designated national technical group for translation and conversion into the national format. In the case of the Royal Air Force, this data is ultimately supplied to the Central Flying and Development Establishment technical team, which then drafts

the detailed maintenance handbooks. On the German side, a different process is followed: here the data is passed on to a manufacturer, MBB for example, which holds a separate contract from the Luftwaffe to define and carry out the maintenance procedures.[160]

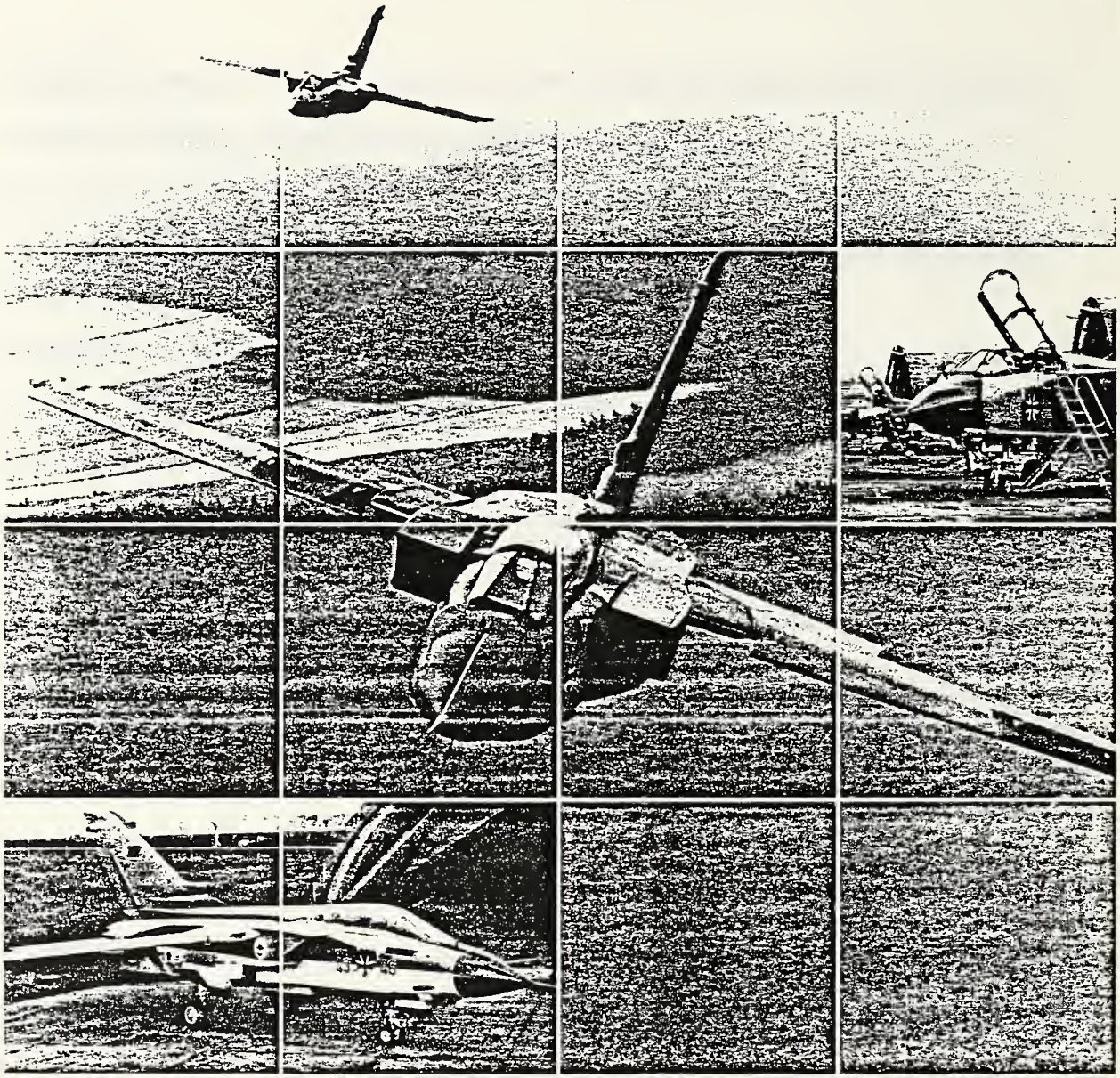
As the participating countries have, in many cases, selected the same piece of equipment, spares requirements can be defined quickly and reliably, helping to keep costs down. The three partner governments together are naturally able to obtain more favorable conditions for the supply of their initial requirements than they could acting separately.[161]

Moreover, common evaluation at the beginning of the in-service phase will provide accurate consumption data fairly quickly, and thereby the initial needs of the Tornado program can be met with a smaller inventory of spare parts.

Another Panavia support activity is a result of NAMMA's intention that the whole of the technical documentation for spare parts and ground and test equipment was to be drawn up to uniform standards by the manufacturers, even though the end-product described in the handbooks might have to conform to the special, national requirements of one of the four air services. Any alternative to this approach would mean that, for example, the British supplier of a given aircraft system would have to work according to three sets of specifications: a British Illustrated Parts Catalogue in accordance with Aviation Publications 70, a German GAF-TO and an Italian TTI specification.

Instead, each supplier, after receiving a Panavia specification, provides a uniform set of data in return, and eventually obtains a uniform procurement

F-505/83F



Avènement d'une nouvelle génération

MBB

Partenaire de programmes internationaux

En moins de deux ans, des equipages militaires d'Allemagne, de Grande-Bretagne et d'Italie ont totalise 20.000 heures de vol sur l'avion de combat europeen Tornado. Apres avoir equipe le centre d'instruction trinational de Cottesmore (Angleterre), le Tornado est maintenant en service dans la Bundeswehr. Pour les escadres des forces aeriennes et aeronavales, cela represente l'avenement d'une generation d'aeronefs qui établit de nouvelles règles sur les plans aeronautique, operationnel et technique.
MBB, en sa qualite de partenaire allemand au sein du consortium Panavia, a contribue de manière déterminante à la mise au point, couronnee de succes, du Tornado pour les forces aeriennes europeennes de l'OTAN. Et puis dans les phases de mise en service et de mise en œuvre du systeme d'arme, MBB sera au service de la Bundeswehr en tant qu'entreprise nationale responsable de l'ensemble du systeme au stade de la fabrication et dans le domaine de la maintenance.

Messerschmitt-Bölkow-Blohm GmbH
Division Avions Militaires
Postfach 80 11 60
D-8000 München/Allemagne
Téléphone (0 89) 60 00-57 11

contract. Later Panavia reinterprets the manufacturer's data in terms of the appropriate national specifications listing.

The whole of the procurement process for spares and equipment in the Tornado program is analogous to that described in the example above. In the Industrial Procedures conferences organized by NAMMA, the overall quantities of spares for the three nations are established and fed into a central computer system at Panavia. The computer then prints out a contractually binding list of the required volume of spares. This listing is then sent to NAMMA, which draws up a Spares Order and returns it to Panavia for execution. This computer system carries all of the spare parts data, including that pertaining to quantities and codification. In all, this totals some 80 data entries for every part, for about 250,000 different parts.[162]

This data bank is available in three identical installations—each Panavia partner company has received the same set of data—and each firm can therefore deal directly with its own national procurement authority in order that vital decisions can be made immediately. Spare parts orders, printed out by the central computer, are converted by Panavia into production contracts for one of the three member companies or into procurement contracts for a subcontractor.[163]

Defects, anywhere in the weapon system, are reported by the air force concerned to the Panavia member in that country, which then coordinates with the other member firms to correct the fault in a tri-national effort. As matters now stand, this procedure will be followed only as long as the tri-

national production program is in progress. The participating countries may later agree to make other arrangements.[164]

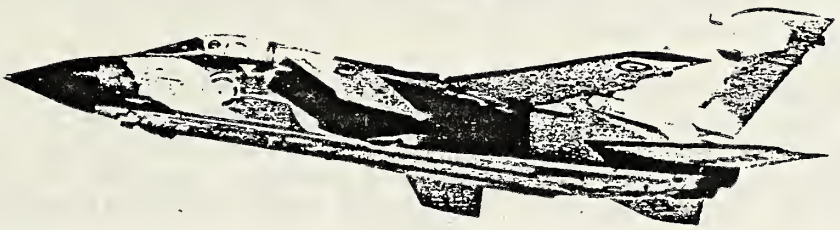
As for the RB.199, the product support scheme makes use of the combined resources of Rolls-Royce, MTU and Fiat Aviazione. It is the subject of direct contracts between NAMMA and Turbo-Union, and, for certain activities, between individual companies and their national Air Forces. For the first time on a European engine, all product support activities (spares, planning, maintenance philosophy, ground equipment, technical publications and training) are based on a modular concept. The approach has already been successfully employed through-out the flight development program.

It should be evident from the preceding description of product support arrangements that NAMMO and Panavia represent the most advanced of the government and industry mechanisms for the transnational procurement of a weapon system.

> The overriding concern of NAMMA regarding the support system was that the procedures adopted should allow maximum flexibility - a desire strongly endorsed by Panavia. This flexibility is expected to make a major contribution to keeping program costs to a minimum, particularly in the first two years of operational service, when only a hundred or so aircraft will be delivered, and the whole maintenance and servicing system will be at the highest part of the learning curve.[165]

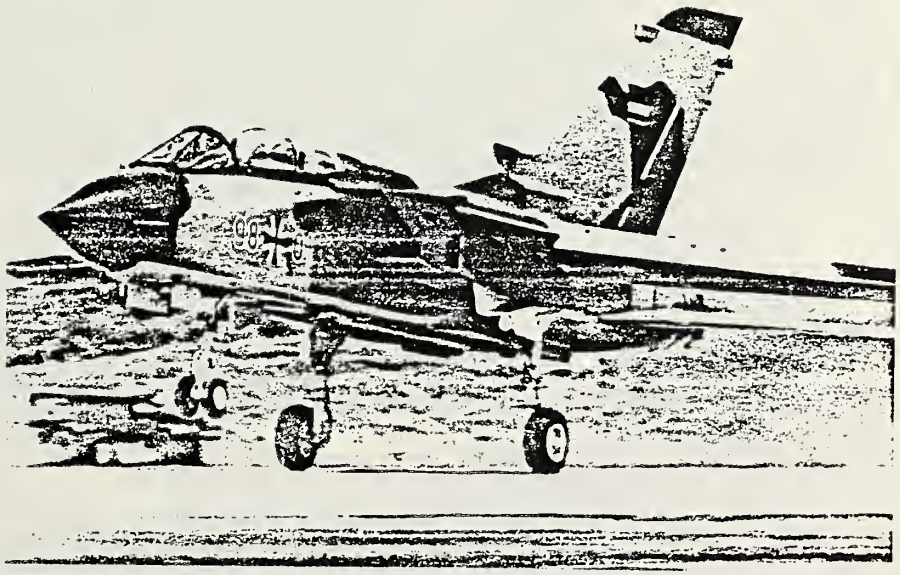
10. Panavia and the Future

To the Miltech question: "On the basis of the experience to date, would one fall back on Panavia for a new project? What might be done differently?" Fichtmueller responded at some length:





An MBB design for the TKF 90.



TORNADO: to be fitted with reconnaissance pods for German Air Force?

I feel sure that at least a similar form would be chosen—and this also applies to future programs.

Collaboration projects of this order of magnitude and sophistication call for a focal point of common decision making—clearly recognizable to all—and a staff of employees instructed to reach the required decisions. Without such a center, a program of this kind dissolves into the pursuit of a great many individual goals.[166]

Thought may be given to the question of how to staff the 'center' and whether or not to shift the dividing line between centralized and decentralized management. Furthermore, the line of communication between the customer organizations and the partner firms could be organized differently. At any rate, the organization of the TORNADO with Panavia as integrator provides a felicitous example, in my view, of the industrial organization of overall management.[167]

If the number of participants in a new program remains constant, then the governments will probably take Panavia as their model. As there is now much more mutual knowledge than ten years ago, some changes in certain sectors could not be ruled out. That would render cooperation in the next program easier and reciprocal confidence greater. In my personal opinion, however, the changes ought to take place wherever relevant in the implementation of the work and not in its fundamental organization. For example, there could be a reduction in the verification functions or rather the interlinking of all partner firms including systems and construction groups not located in their sphere of work.[168]

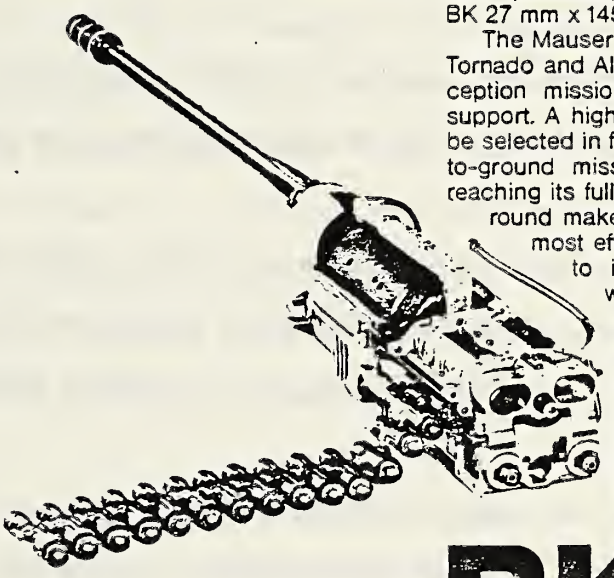
The way in which a future combat aircraft program is managed—both on the governmental and the industrial side—will hinge upon a variety of factors, including not least the number of participants. As future international cooperation in Europe will probably only set out to develop one aircraft weapon system at a time, very precise thought will probably be given to the solution involving one pilot state and one pilot firm. Although this approach is aimed at in the missile programs, the latter are smaller, and the number of projects larger. If a different form of organization is desired for a future common aircraft project because certain aspects of Panavia or NAMMA do not seem optimal, these changes ought in my view to be carried out for the TORNADO inasmuch as the alteration in question is relevant to the current phase of the program.[169]

The following subchapter on the Alpha Jet will provide us with an example of an alternate approach to collaboration. The Alpha Jet involves such differences as: the set of national and industrial actors; management and collaborative philosophies; system complexity; number of participating

The best is just about good enough.

A powerful aircraft gun system is characterized by the high terminal effectiveness of its ammunition and by favourable installation parameters, such as low weight, small volume envelope and low reaction forces. These characteristics are impressively reflected by the Mauser BK 27 mm x 145 automatic cannon.

The Mauser BK 27 is installed in the Tornado and Alpha-Jet aircraft for interception missions and ground combat support. A high and low rate of fire can be selected in flight for air-to-air and air-to-ground missions. The capability of reaching its full rate of fire from the first round makes the BK 27 one of the most effective aircraft guns. Due to its low reaction forces, which are achieved by means of a floating buffer system or the specially developed damper system, the gun can be installed even in extremely light aircraft structures. Different types of projectiles with identical trajectories permit mixed belts.

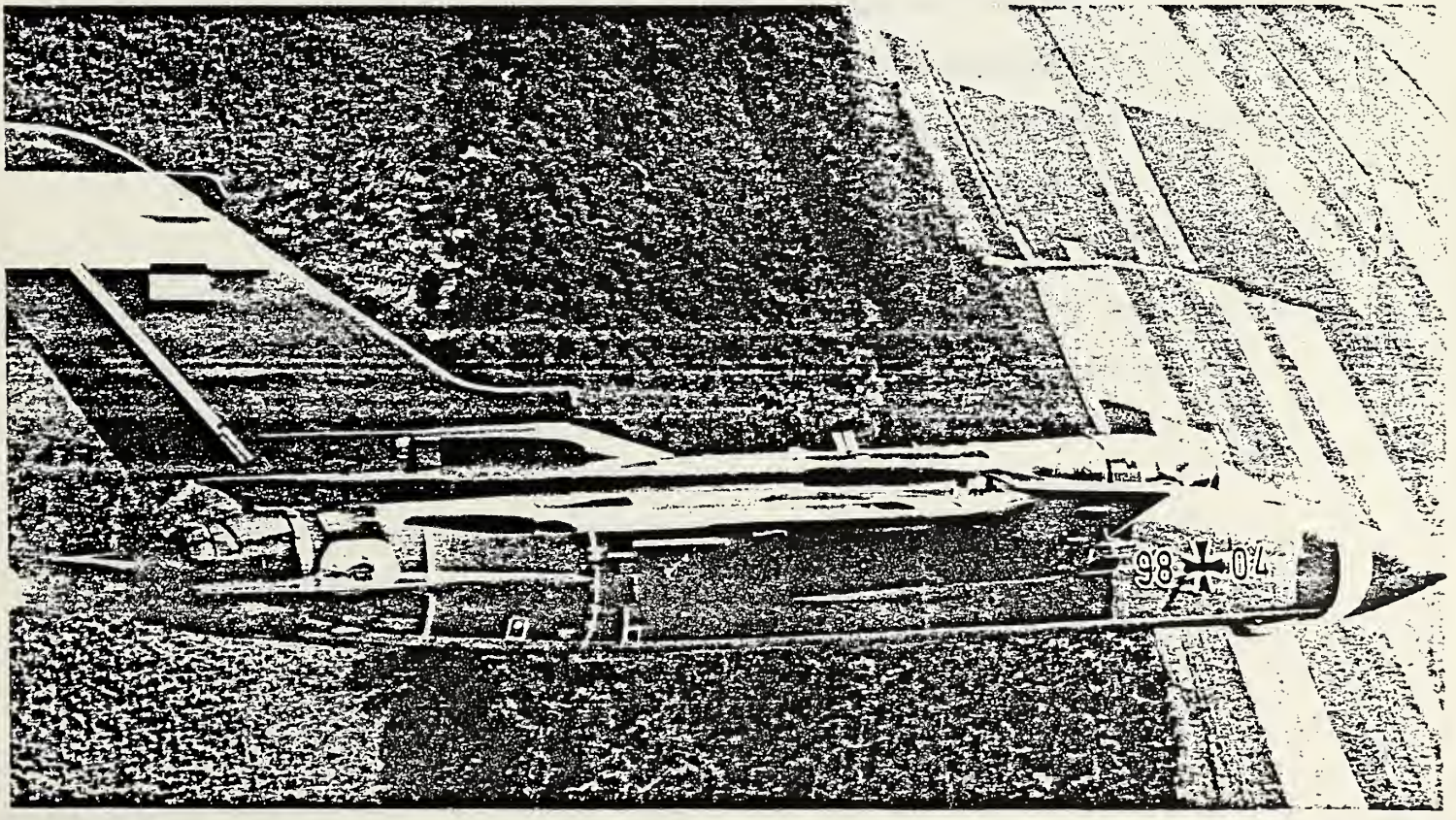


BK 27

MAUSER-Werke Oberndorf GmbH
7238 Oberndorf

MAUSER

A leader in gun technology.



nations; approach to source selection, size of firms and so forth. Nevertheless, comparison of the two projects is a worthwhile exercise.

11. MRCA Problem Areas

Some of the important problems encountered in this largest of all joint development and production programs were commented on by:

- A.H.C. Greenwood, Deputy Managing Director BAC Ltd. in a lecture given at the Royal United Services Institute (RUSI) and published in the RUSI Journal for Defense Studies of February, 1972, and;

- Gero Madelung, Manager Director, Panavia Aircraft GmbH at a NATO Procurement Workshop in 1974 (as reported in General Research Corp.'s 1976 study on NATO Licensing, Vol. II, p. A-29);

- Ludwig Boelkow of MBB at the 40th meeting in early 1976 of the German Society for Defense Technology, the Working Group on Defense Research concerning International Cooperation in the Equipment Sector, reported in the April 1976 issue of the International Defense Review;

- Dr. C. P. Fichtmueller Managing Director of Panavia in an interview with Military Technology and Economics in late 1979.

1) A.H.C. Greenwood made several observations pertaining to problems encountered in the MRCA program. First, the selection of equipment proved to be a slow process due to the system of ratification by government

selective committees. Mr. Greenwood cited this procedure as one that exemplifies one of the main problems in such a project, i.e., the degree to which government surveillance of such programs should extend.

2) Secondly, there was a serious problem with regards to protecting the interests of the highly sophisticated British avionics industry as subcontractors to its nation's main subcontractor (BAC), and in the MOU, where the avionics industry tended to be used as a balancing agent without proper concern for compensation through royalty and licensing arrangements for technology and know-how transferred to continental competitors.

3) Mr. Madelung's comments in the area of requirements were that, although it took considerable time to arrive at a concensus, the extensive joint effort of the three Air Staffs in coming up with a common requirement contributed in part to an alignment of their operational philosophies, as well.

4) This problem of a common requirement was interrelated with, and further aggravated by, the diversity of the aircraft's external stores for each of their version(s).

5) In some areas, such as communications equipment, it has been necessary to provide different "national fits", because the three national Air Forces and 1 Navy involved preferred to maintain interservice standardization, over international standardization.

6) In order to avoid the problems and delays encountered during MRCA contract negotiations between industry (i.e., Panavia) and one of NAMMA's 52 subcommittees, Mr. Boelkow proposed that negotiations take place between Panavia and NAMMA directly—as is the case with Euromissile, which deals directly with the permanent Franco-German Program Office.

7) According to Mr. Boelkow, the division of work is the most difficult problem in multinational programs—necessitating over two years of hard preliminary bargaining on this question alone for the MRCA project. Contributing factors were: the differing capabilities of the national industries resulting from post-war developments; as well as the nature of the relationship existing between industry and state in each of the three countries.

8) In conjunction with this, other problems of multinational defense contracting were differing conditions of contract, various profit margins, German export restrictions, differing logistics requirements, as well as those problems emanating from the differing national economic environments—inflation, currency fluctuations, piece rates, etc.

9) On several of the same points Mr. Madelung observed that it was difficult for the participating governments, influenced by their national industrial associations, to reach agreement on a uniform standard of contractual conditions. In addition major aspects of government contracting philosophies—pricing in particular—were different.

10) According to Mr. Madelung, not all European firms involved were experienced in transnational subcontract management. For example a

supplier in one country subcontracted part of its work to a supplier in another country would sometimes find it difficult to execute full contract performance responsibility.

11) Mr. Boelkow also mentioned particular problems which arose with subcontracting in the FRG due to the less developed stage of the German electronics and equipment industry.

12) Mr. Madelung observed that, although the MRCA started out using MIL standards—which had been fully introduced into two of the participating countries (FRG and Italy) through previous cooperative defense work—there were a large number of detailed problems arising from standards, manufacturing processes, and test procedures—all of which required a considerable effort.

13) With the MRCA, as Mr. Boelkow pointed out, about 18 months had to be spent in the definition phase, but at least development started on the basis of clearly formulated requirements—unlike Euromissile's Milan project.

14) Moreover, if they had not encountered such difficulties in the area of engine development, the project's number one problem area, the development program would have been on target, both as regards cost and time.

15) Fichtmueller made the comment that with regards to new programs, any changes made in the Panavia model should take place wherever relevant in the implementation of the program's work and not in its fundamental organization. As an example he cited the possibility of a reduction in verification functions, or rather the interlinking of all partner firms including systems and construction groups not located in their sphere of work.

16) The author considers it important to point out two additional aspects of the project brought out in this project history. First, the MRCA consortium lost all of the minor participants except for Italy, which was retained in good part through subsidy. Among the minor nations dropping out, the Netherlands was particularly significant in the role it played, both in its initiating of the project and in the reasoning behind its withdrawal, a withdrawal that was to lead to the formation of the F-16 consortium as an alternative to the MRCA, in the European production of an F-104G replacement aircraft. The Netherlands, and for that matter the smaller nations of Europe, wanted a less expensive and less complex aircraft. Unlike Europe's medium powers, they were not inclined to pay the premium required for participation in such an advanced development project as the MRCA, especially since the ultimate design of the aircraft would be one optimized around a trade-off between the major participants, the British and Germans. Here we see the principal reason behind the Dutch-Belgian-Danish-Norwegian, and (once again) separate Canadian shopping trips of 1974-75[170] and 1977- 80,[171] to find the best deal for themselves individually.

17) Secondly, though political considerations will force the selection of certain key systems from domestic sources within the consortium of nations (as with the engine for both the MRCA and Alpha Jet), more 'objective' competitive pressures of cost, risk and performance will continue to prevail in the certain key avionics systems, thus allowing U.S. industry a not insignificant role in such European development projects.

F. The Franco-German Alpha Jet

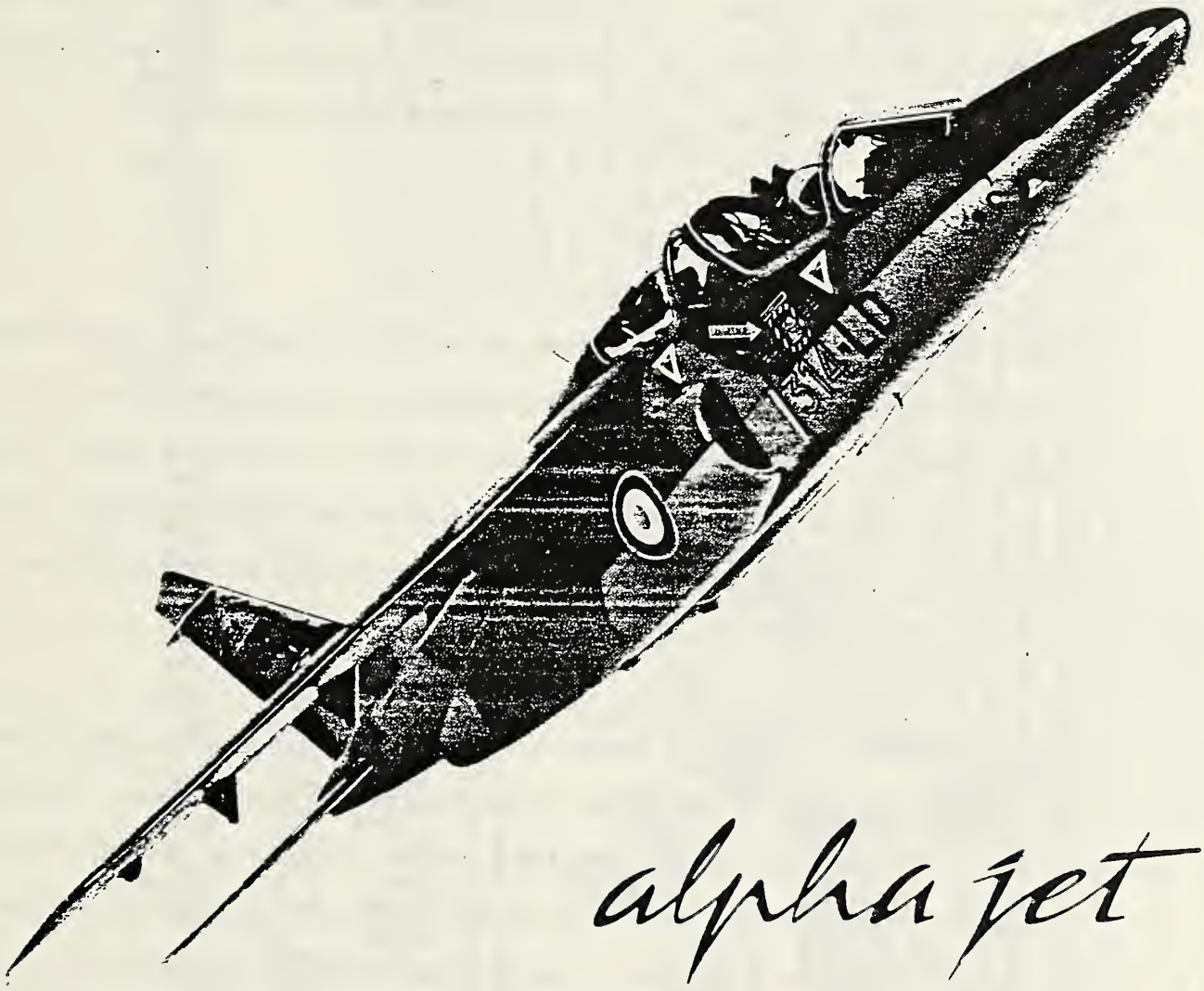
1. The Competition

The configuration of the Alpha Jet is a meld between the Breguet 126 and the Dornier P.375. It originated from two independent design studies initiated in 1967 by the two firms (both partners in the NATO Atlantic Maritime Patrol Aircraft project originating some 10 years earlier) for a trainer to enter service in the mid-1970's. In early 1969 Breguet and Dornier decided to team up (Breguet Aviation had since merged with Avions Marcel Dassault to become Dassault-Breguet) to compete for the French and German governments' common selection of a jet trainer, a joint project agreed to by the French and German MOD's in May, 1969. The competitor was another Franco-German consortium including Sud Aviation (shortly to become part of Aerospatiale (SNIAS)) and Messerschmitt-Boelkow-Blohm with their Sud/MBB Eurotrainer.[172] VFW also submitted a proposal, but lacking a French partner could not be considered a serious competitor.[173]

The French and German governments each established firm requirements for 200 of the aircraft. Design performance points were Mach 0.8-0.9 maximum speed, a 45,000 ft ceiling, and a 90 kt landing speed. The French government also specified that the aircraft be small and cost less than $1 million. Although originally considered as primarily a trainer, a secondary mission for each country was to be the adaptation of the trainer to serve in a close support role.

This was not considered a driving requirement, but the aircraft was to be fitted with internal guns and stores hard points.[174]

N'importe quel avion d'entraînement apprend à voler. UN SEUL apprend à combattre.



alpha jet

Pour entraîner un pilote de combat, une armée de l'air moderne a besoin d'un avion d'entraînement dont les qualités de vol soient les plus proches possible de celles d'un avion de combat. Parce qu'il est le seul avion d'entraînement à avoir également été conçu dès l'origine comme avion de combat, l'ALPHA JET est de loin le plus efficace. Certains avions d'entraînement évitent délibérément certaines manœuvres délicates en vol: au contraire, parce que son pilote aura peut-être à les exécuter un jour au combat, l'ALPHA JET lui apprend ces manœuvres en toute sécurité et le rend plus confiant et mieux aguerri. C'est pourquoi l'ALPHA JET est vraiment différent.

DASSAULT-BREGUET/DORNIER

The proposals were due on January 2, 1970, and source selection was to have been made by March 31. The Dassault-Breguet/Dornier design was eventually selected in July. The French and German governments signed a protocol the same month to start the definition phase. Development costs at this time were expected to total $275 million. Deliveries were to start at the end of 1975, and the first squadron was expected to be operational in early 1976.

2. Three Major Program Hurdles

Shortly before the program was launched in mid-1970, however, it encountered two major obstacles, one of political/diplomatic origin and the other of technical/industrial origin that amply provide examples of the extra costs involved in multi-national collaboration for the development of weapon systems; extra costs that the three European medium powers have learned to live with, but that the U.S. apparently has not.

The first of these involved a German volte-face on their military requirement which was the main factor contributing to the systems cost increase. The German reversal involved a decision to use the Alpha Jet as a close support aircraft to replace the Fiat G-91, rather than as a trainer. A secondary role in which it would also be used, was combat zone reconnaissance - a modification of the ground support version that would involve little additional expense.[175] The French, who wanted a basic and advanced jet trainer with only limited ground support capabilities to replace the Fouga Magister, did eventually agree to the changes in mid-1970, but redesign work slipped the program by several months. Costs rose accordingly, which resulted in the number of flying prototypes and preproduction aircraft being cut from ten to four units.[176]

No chance-decision nor forced-decision when eight countries select the Alpha Jet*

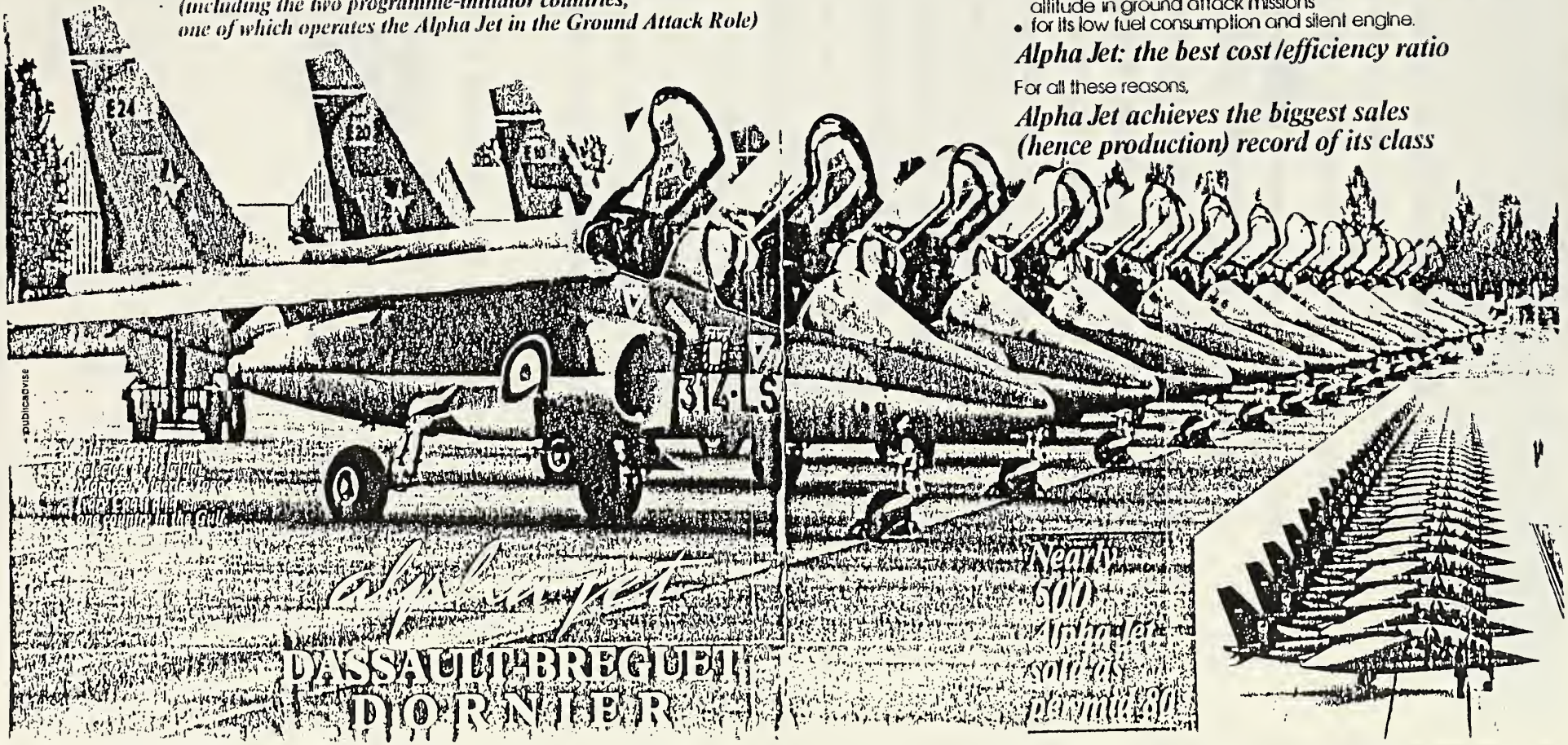
(including the two programme-initiator countries, one of which operates the Alpha Jet in the Ground Attack Role)

- for combat pilot training
- for its 1980/2000 technology (aerodynamic - structures - propulsion - flight controls...)
- for its performance, the highest in its class
- for its flight handling qualities and manoeuvrability at low altitude in ground attack missions
- for its low fuel consumption and silent engine.

Alpha Jet: the best cost/efficiency ratio

For all these reasons,

Alpha Jet achieves the biggest sales (hence production) record of its class



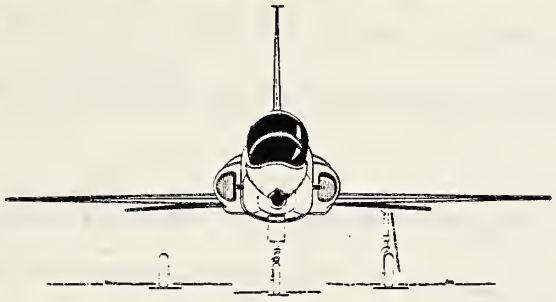
Alpha Jet

DASSAULT-BREGUET
DORNIER

Nearly 500 Alpha Jets ordered or planned

Originally the Alpha Jet had been intended for use as a basic trainer for Luftwaffe pilots training in France as part of a joint training program with the Armee de l' Air, but strong U.S. pressure on the FRG regarding the BOP problems caused by U.S. troops stationed in the FRG, resulted in the FRG extending its commitment with the USAF to continue training its pilots in the U.S.[177] Despite these conflicting commitments to two of its three major allies, the FRG was anxious to salvage the new aircraft program.[180] Therefore the FRG subsequently altered a number of the design specifications to make its version of the Alpha Jet primarily a close support replacement for the Fiat G-91, and cut back its MRCA Tornado order by the equivalent 200 aircraft (a joint project with its third major ally). This reduction in the MRCA order by a transferring of one third of the requirement to the Alpha Jet, allowed the FRG to circumuent the last major impass in the definition phase of the MRCA by eliminating a single seat version, and thereby reducing development costs by an estimated 20%. This ended the original intent of the FRG to replace both the F-104G and the G-91 by a single aircraft. In addition to the Germans reducing their tornado order by 200, the Italians cut theirs in half bringing it down to 100, for a total projected order base reduction of 300 aircraft.

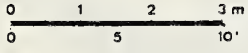
The MRCA tornado had been the second aircraft to be targeted by the Luftwaffe as its G-91 replacements. Back in the spring and summer of 1967 the FRG had been on the verge of adopting the Jaguar and joining in the Anglo-French Breguet/BAC project, but opted out in the end.

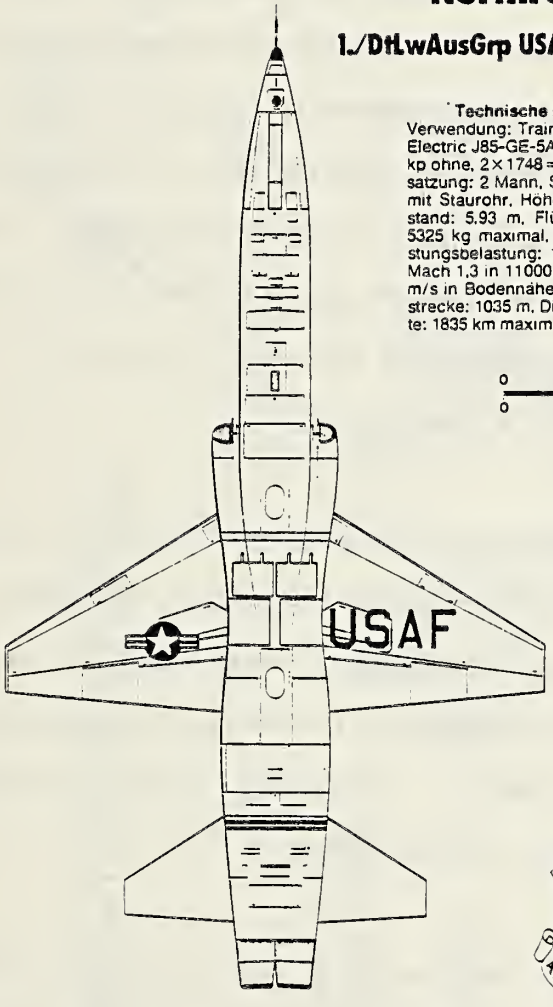


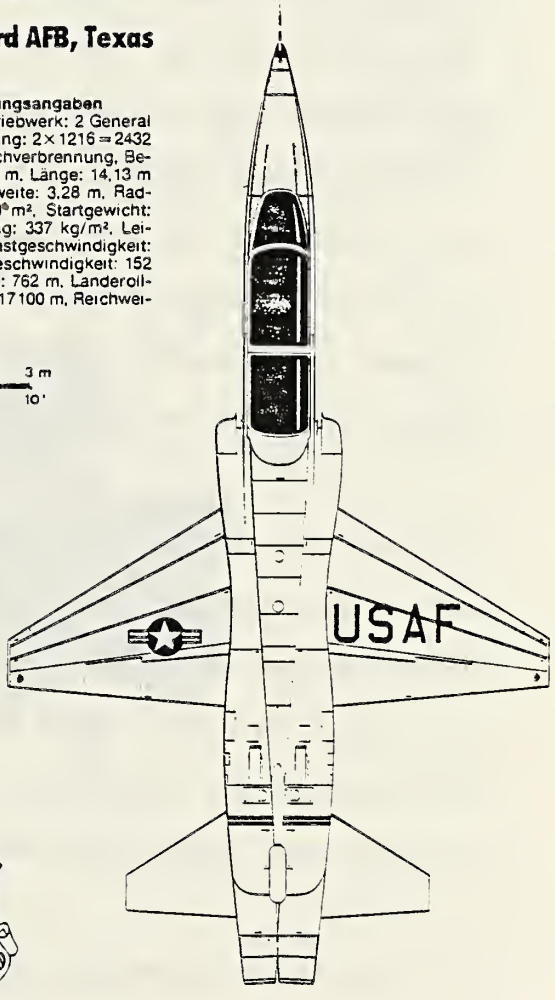
Northrop T-38 A Talon

1./DtLwAusGrp USA – Sheppard AFB, Texas

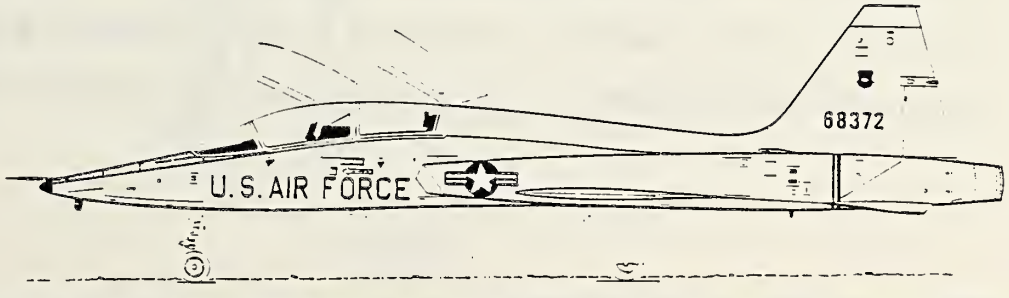
Technische Daten und Leistungsangaben
Verwendung: Trainingsflugzeug, Triebwerk: 2 General Electric J85-GE-5A, Triebwerkleistung: 2 × 1216 = 2432 kp ohne, 2 × 1748 = 3496 kp mit Nachverbrennung, Besatzung: 2 Mann, Spannweite: 7.69 m, Länge: 14,13 m mit Staurohr, Höhe: 3,94 m, Spurweite: 3,28 m, Radstand: 5.93 m, Flügelfläche: 15,80 m², Startgewicht: 5325 kg maximal, Flächenbelastung: 337 kg/m², Leistungsbelastung: 1.52 kg/kp, Höchstgeschwindigkeit: Mach 1,3 in 11000 m Höhe, Steiggeschwindigkeit: 152 m/s in Bodennähe, Startrollstrecke: 762 m, Landerollstrecke: 1035 m, Dienstgipfelhöhe: 17100 m, Reichweite: 1835 km maximal.











CHR

Zeichnung: Rademann

Though at first France had rejected this concept of a dual role for the aircraft, the Germans stood firm and the French eventually came around to accepting it as part of a compromise involving the second problem.

The second of the two problems that collectively delayed the launching of the program by some three and a half months was over the selection of an engine; with the FRG taking the same stance as it had taken the previous year over the MRCA's engine choice, i.e. the Germans wanted an off-the-shelf American engine that offered lower cost/risks and appeased U.S. sensibilities, while their principal European partner (this time France) was pushing for its own competitive system, but one which was not at a comparable stage of development. The FRG wanted the General Electric J85 engine (the one used in the Northrop F-5) to power the Alpha Jet, while France insisted that the power plant be its Snecma-Turbomecca M49 Larzac, still in development.

In return for France accepting the redesigning of the aircraft, the FRG eventually compromised and accepted an improved version of the Larzac, the M49-04. As of the signing of the protocol in July 1970 though, France was still expected to install the Larzac M49-02 and the FRG maintained its refusal to pay development costs of the higher thrust M49-04 version. This latter point continued to be an open issue, after the signing of the agreement.

As a result of compromises on the part of both nations, the French basic and advanced trainer version, and the German close support version of the Alpha Jet are still almost identical with regards to the airframe, engine, undercarriage, and standard equipment. The principal reasoning behind the decision to

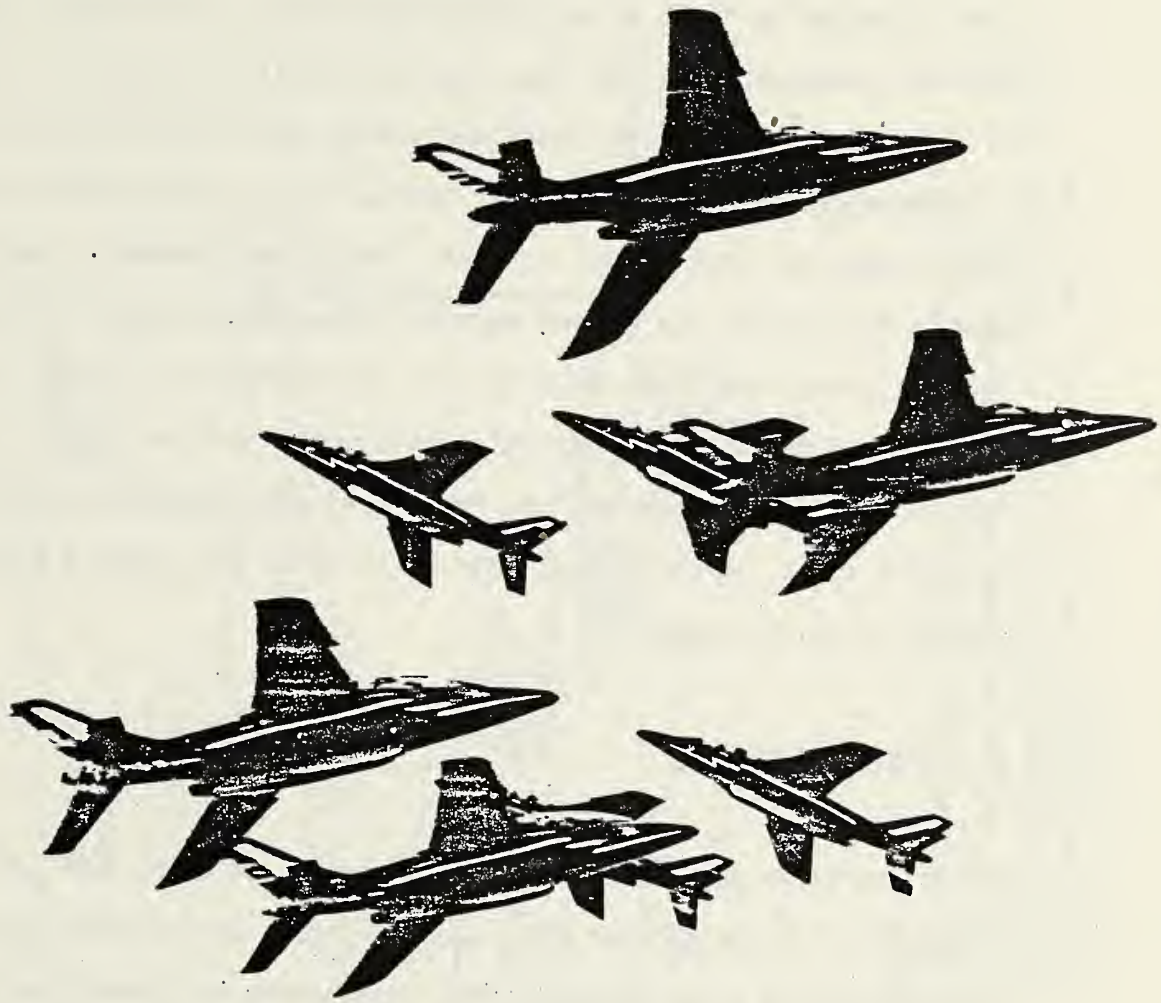
Alphajet Participating Nations



standardize the airframe to as great an extent as possible reportedly stemmed from the negative experiences of prior multi-national programs in this regards. As an example, the French version has the strengthened points required by the German aircraft for fitting a runway arrester hook, although the hook will be installed afterwards only on the German version. Other differences between the two versions include: for the Germans, a steerable nosewheel, a simple navigation/attack system, and four underwing pylons for rockets and bombs, heavy duty brakes with a modulated anti-skid system, the runway pylons equipped with rocket launchers, a simpler wheel braking system, and a 30 mm DEFA 553 cannon.[181]

The French version of the Alpha Jet is the baseline aircraft. The Franco-German protocol finalized in March 1972 stipulated that the two nations would share equipment fit the cost of the trainer verison was estimated in 1976 to be costs of the trainer equally, but that all extra costs for development of the close support aircraft would be borne by the FRG alone.[182] Because of its simpler around 25% less than that of the ground support model. The program unit costs were estimated in early 1977 to be around $5.3 million for the French Alpha Jet and $7.1 million for the German Alpha Jet (the flyaway price of the German Alpha Jet was $4.7 million).[183] The major difference in the price tag of the two systems was accounted for by the additional avionics required for the German ground attack mission.[184]

Yet another major problem of political origin that the program faced involved export limitations placed by the FRG on the aircraft. This delayed completion of a development contract for the aircraft, as France insisted on being allowed



Avions, Formations

Croisement des deux "boîtes" de la Patrouille de France au meeting aérien de la Ferté Alais, organisé par l'Amicale Jean-Baptiste Salis. Ce meeting a lieu lors du dimanche de la Pentecôte, chaque année.
En plus des "classiques" avions anciens, la prestation 1982 permettait de voir un P51 Mustang et un F6 Bearcat (photo Sirpa Air).

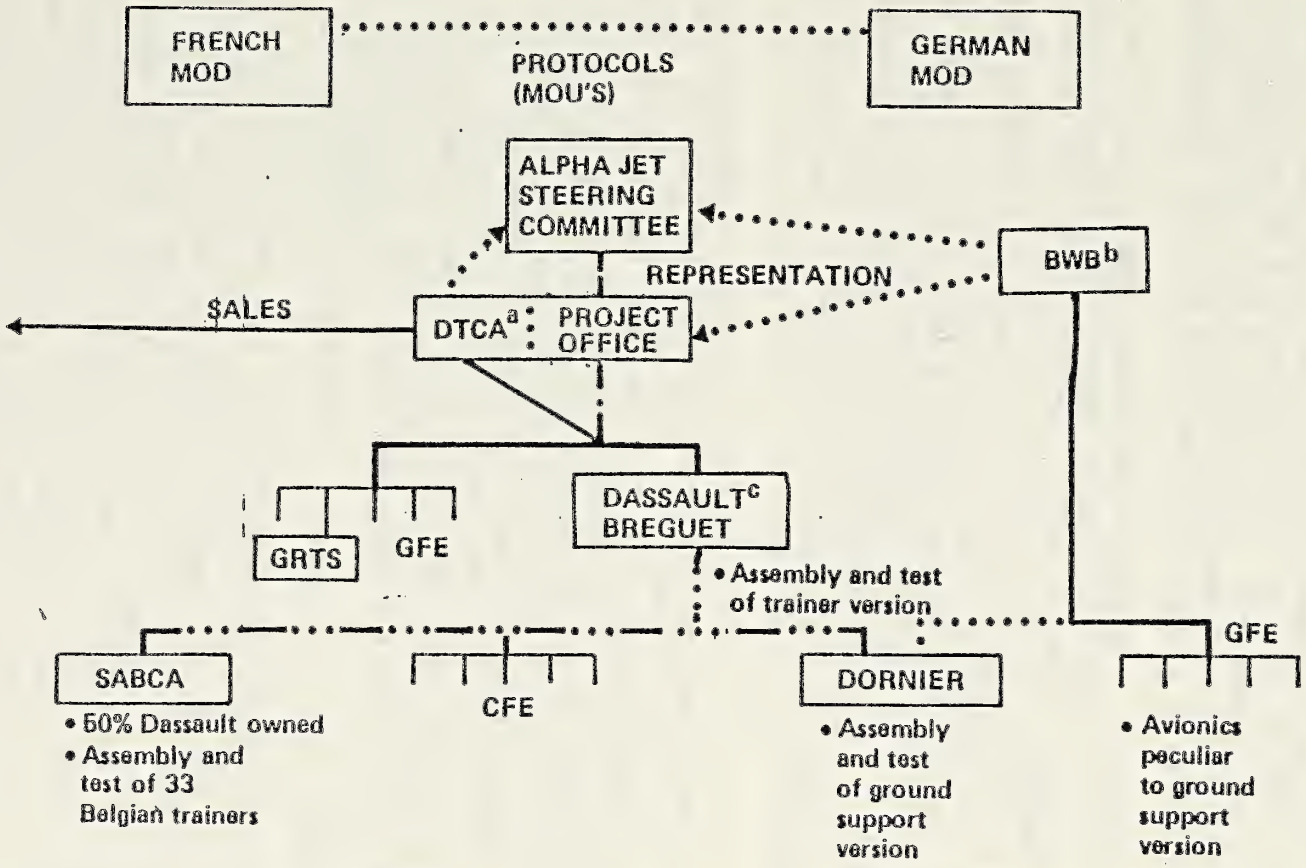
to export the Alpha Jet to whatever nations it chose. The FRG, contrary to France, wanted to limit sales to NATO members only. This export issue is generally considered to have been the most significant obstacle contributing to the program's delay. Although the project definition phase was completed in February 1971, agreement was not reached until February 1972, with the contract signed the next month, in March. Under the agreement, France would be able to export only the trainer version without restriction as to buyer nations (and of course, the Alpha Jet's trainer version does still have a certain amount of dual-role capability, which makes this easier to live with). Again, in late 1974 export related problems resurfaced over production contract provisions on export sales, which held up talks until April 1975, when a production agreement was finally signed.[185]

3. The Airframe Team

The relationship between the two firms involves an equal sharing of the design, development, and production work, while France's Avions Marcel Dassault-Breguet Aviation acts as prime contractor for development and production and the FRG's Dornier acts as associate contractor. Consequently, unlike its predecessor the Fiat G.91, which was built under license in the FRG, German industry this time was an equal partner in joint development.[186]

Under the guidance of the Franco-German Alpha Jet Steering Committee all development contracts were awarded by France's Direction Technique des Constructions Aeronautiques (DTCA) to Dassault-Breguet, the DTCA having been chosen as the contracting agency for both the French and German governments. There was an

The Franco-German Alpha Jet



Legend:

— — — Policy/guidance

— · — Project management

——— Contracts

· · · — Subcontracts

· · · · · · Other

Notes:

[a]France's Direction Technique des Constructions Aeronautiques (DTCN).

[b]The FRG's Bundesamt fuer Wehrtechnik und Beschaffung (BWB).

[c]Although contractually Dornier is a subcontractor to Dassault-Breguet, the project is a 50:50 one with regard to the sharing of design, development, and production responsibilities.

integrated two company design team at Dassault-Breguet's St. Cloud facility[187] under the leadership of the Dassault-Breguet general manager.[188] The whole program is handled to French specifications, standards, and practices, as agreed between the two governments. This naturally meant that production documentation in the FRG had to be adapted accordingly.[189] This can be contrasted with approach adopted for the MRCA Tornado where standardization was on the basis of internationally agreed to norms. Whereas English was adopted as the program language for the tornado, partially as a trade-off involving location, there is no one official language for the Alpha Jet project. French and German both equally used. All official negotiations are conducted with interpreters, while French and German are used, as well as English, at the working level.

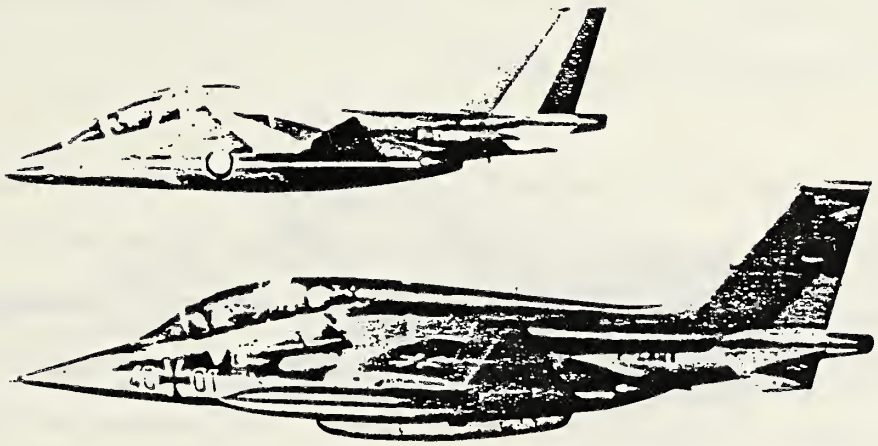
In lieu of the prime/associate contractor relationship described above the principal competing consortium, SNIAS and MBB, had opted for another solution, the establishment of the Eurotrainer Grouement d' Interet Economique (GIE) which in turn would subcontract to the two collaborating firms. Forming a GIE gives a consortium more legal status than a simple international joint venture. Therefore the laws of the group were French, and project leadership was vested in the French partner as with the prime/associate relationship, but the German contractor would have had somewhat less of a second class status.[190] With the Eurotrainer GIE the two companies intended to formulate an integrated project group, and were to attempt to avoid issuing work packages for each member company. Rather, the idea was to integrate teams from both companies in all phases of the program. The competitive proposal, for example, was written by a combined team of 20 designers from each company in Munich.[191]

It's of some note that the nature of firms making up the two competing teams lined up so well. SNIAS and MBB are both larger more bureaucratized firms that are conglomerates of a number of older firms that had been merged, whereas Dassault and Dornier were smaller more entrepreneurially oriented firms.

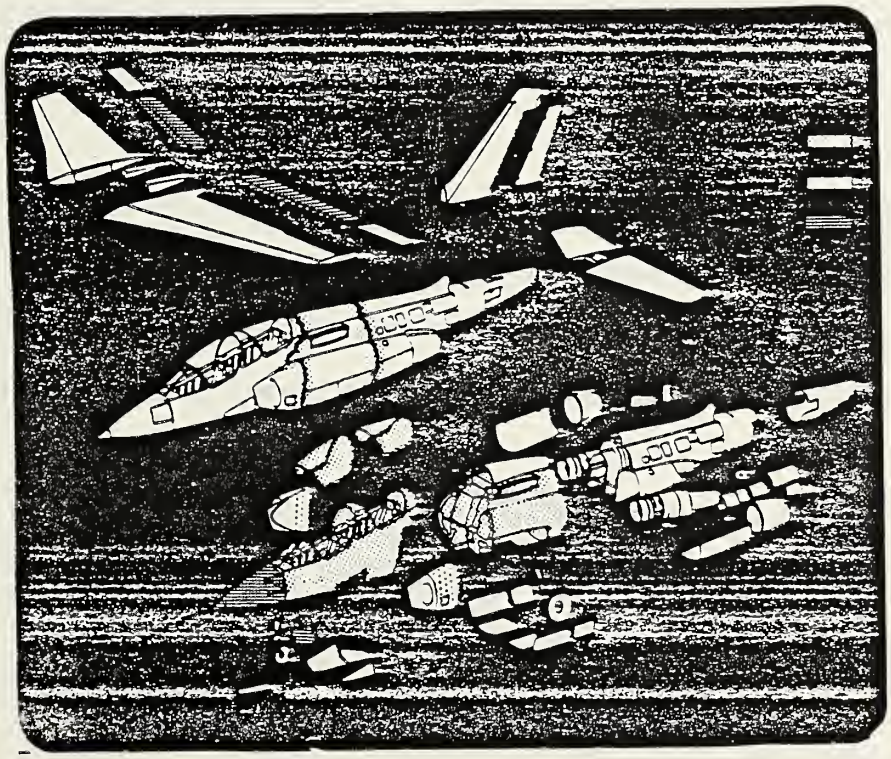
Even though all contracts are awarded to Dassault-Breguet, which then subcontracts to other companies, including Dornier, it must be reemphasized that this is a 50:50 collaborative program, and Dassault-Breguet officials are very insistent on this point. Dornier is not the lesser partner. The airframe production work, equally divided between Dassault-Breguet and Dornier, involves no duplication of subassembly production. But there are two assembly lines, one at Dassault-Breguet's Toulouse-Colombiers plant, and the other at Dornier's Oberphaffenhofen facility near Munich. Each firm is responsible for its own country's particular variant. Dassault-Breguet and Dornier work-sharing arrangements are as follows: Dassault-Breguet builds the fuselage forward section, assembles the fuselage and procures the equipment for all aircraft; and Dornier builds the fuselage rear section, wing unit, tail unit, inspection doors and covers, and air intake.[192]

Other components of the airframe, the fuselage, nose and landing flaps, are being produced on a sole source basis by SONACA and SABCA in Belgium, as part of a 50 plus % offset for the Belgium purchase of 33 trainer versions; a contract signed in September, 1975. Final assembly of the Belgian aircraft will also take place in Belgium, at the SABCA plant in Gosselies.[193]

Alpha Jet



French Trainer and German Ground Support Versions



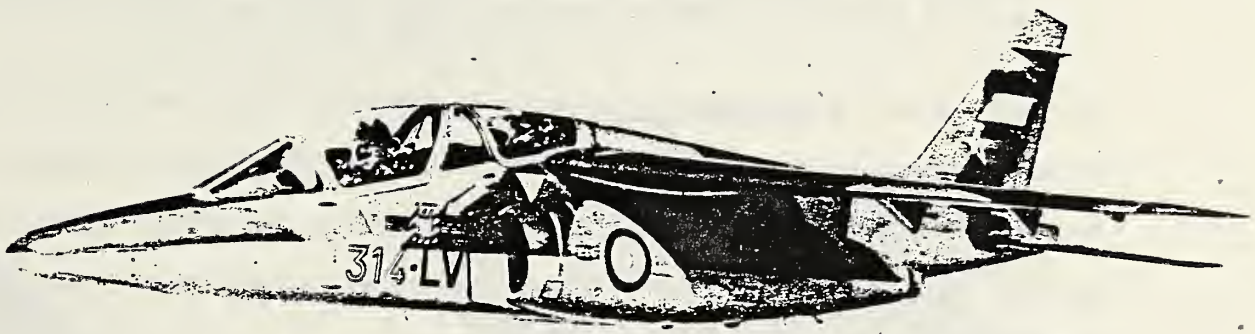
Alpha Jet Work Sharing
Source: Dornier Post

For the ground support version of the Alphajet, assembled at Dornier's Oberpfaffenhofen facility, the Bundesamt fuer Wehrtechnik and Beschaffung (BWB) provides the mission avionics as GFE to Dornier after which the aircraft is procured from prime contractor Dassault.

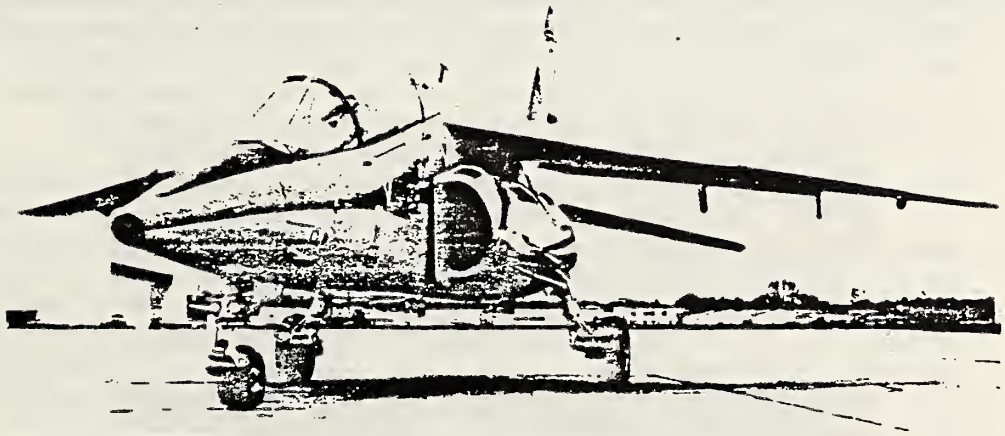
Following the signing of a protocol (i.e. an MOU) on September 30, 1975, between the French, German and Belgian governments, the initial production contracts for 140 aircraft and 420 engines were signed in January, 1976. Despite the prior delays in commencing with actual fabrication of the production version of the aircraft, it continued to move forward. Even before the final production agreement was signed, the go-ahead had been given to procure long-lead time items covering some 37 close support, and 25 trainer aircraft.[194] The first French series aircraft were to be delivered in mid-1977 from Toulouse-Colomiers, the first close support aircraft in October, 1978 from Oberpfaffenhofen, and the first Belgian trainers in November, 1978 from Gosselies.[195]

According to one source, for logistic support the NATO Maintenance and Supply Agency (NAMSA) had been originally considered, but abandoned. One element in the decision on the utilization of NAMSA's services reportedly was Dornier's opposition to this approach, despite the German government's favorable attitude.

In comparing Dassault-Breguet's collaborative experience with the Atlantic Maritime Patrol Aircraft (Chapter 5), the Jaguar (Chapter 13) and the Alpha Jet, Beno Claude Vallieres, Chairman of the Board and General Manager of Avions Marcel Dassault-Breguet Aviation, had this to say in a 1980 interview with Aerospace International:



Fin et démonstratif, un véritable petit chasseur (GE 314).

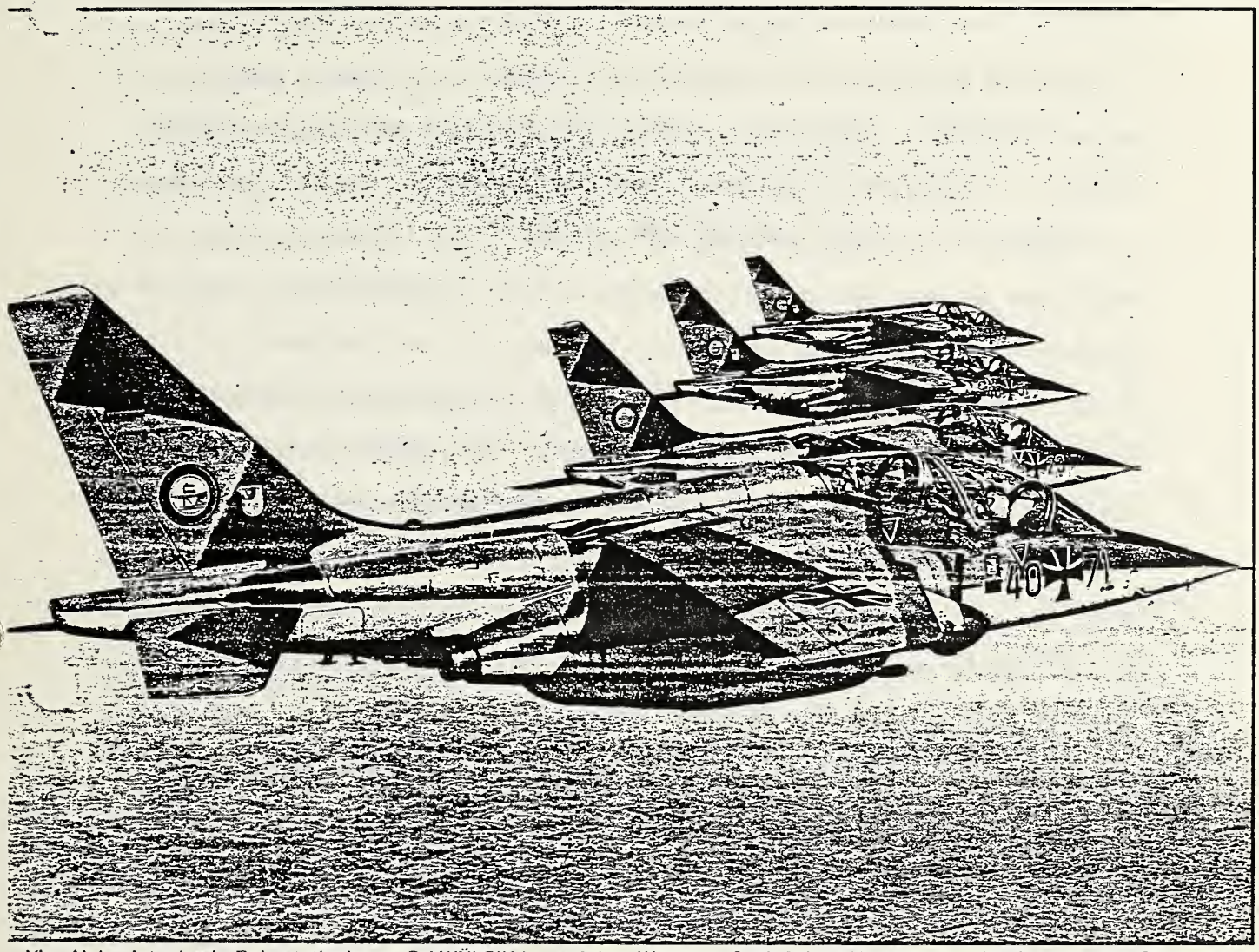


Appareil MS2 ou nouvelle génération école appui (AMD BA).

> The Alpha Jet probably represented the best cooperation which one has had; obviously we had very good relations with Dornier and the results were, that the prototype was ahead of schedule; the flight tests were excellent; as regards engineering, we made them with a mixed team; and the costs were within the limits originally set. Of course we made minor changes on the French aircraft and, as you know, Germany made many changes on their aircraft due to their ground attack mission ... but the basic price of the airframe for the prototypes and the production aircraft was below that anticipated.[196]

In response to the Aerospace International question "Would you prefer bilateral or multilateral cooperation on a future tactical aircraft?", Vallieres launched into the following commentary on Dassault-Breguet's collaborative philosophy and how the Alpha Jet fits into it (especially as opposed to the MRCA Tornado approach, which does not):

> The only answer I could give is that, of course, bilateral is easier than multilateral. But, in any case, we do not want a heavy organization. Someone should be the leader of the whole thing. The experience we had with Jaguar and Atlantic showed that bilateral cooperation is simpler than multilateral, and that monolateral is simpler than bilateral! But we need a good organization. I believe, for example, that the Tornado organization was heavy, though the one we had with Dornier was a very good one. In the case of the Alpha Jet, we worked with common design offices and with common test teams. It was a light and flexible system with a fast decision making capability. We are not interested in working with committees, subcommittees, commissions and subcommissions, because no one is responsible for anything in this system. This does not mean that the higher technology partner should direct the programme and impose its decisions: with Dornier we never imposed anything; when we thought something should have been made in a certain way, we tried to convince Dornier, and if Dornier had a better solution, then we would adopt it. In the Alpha Jet design office the work was shared among Germans and French without knowing who was German and who was French.
>
> At the start of any programme there should be a common viewpoint; a head office should be responsible for the overall design of the aircraft and its systems; each partner should design completely his parts; make the tooling for it, construct parts for the prototype, follow the development and test phase and, finally, put them into production. I do not see the need for an additional, heavier company in this system, because, in any case, the design and cost definition work is made by the manufacturer, and a second company would only duplicate the same work.[197]



Vier Alpha Jets des in Beja stationierten DtLWÜbPlKdos auf dem Weg zum Schießplatz Alcochete an der Ostseite des Tejobeckens



Abrollen zum Start von vier Alpha Jet auf dem Taxiway

4. The Engine

Although the specifications, back in 1969, called for two basic designs - one around the General Electric J85, and the other around the Turbomeca/SNECMA Larzac 02 - observers at that time felt that the trainer program would probably evolve as an all-European project.[198] Originally, it had been planned to fit the German version with two of the General Electric J85 engines, and the French version with two Larzac 02 turbofans. When work on the development of the Larzac began as far back as 1968, it appeared that the engine's principal potential market was in the commercial domain. But, with the development of the uprated Larzac 04 it became possible to fit the same engine to both the French and German versions. With the selection of the Larzac 04 in February, 1972, for both versions of the Alpha Jet, the French government's prior support for the Larzac engine finally paid off, and it's now probable that its largest sales will be found in the military markets. As of mid-1978, it was reported that studies were under way concerning a possible reengining of the Alpha Jet with yet more advanced versions of the Larzac engine. This involves first the Larzac 06, which is a lightweight version of the present engine. This will possibly be followed later by the Larzac 08, which will have a third compressor and increased thrust.

Whereas engine development difficulties had been a major problem faced in the co-development of the Anglo-French Jaguar and the Anglo-German-Italian MRCA, few development problems have been experienced with the Larzac for the Alpha Jet. In fact, unexpected standardization related economies were introduced with the development of the uprated Larzac 04. Although the Larzac was developed

by two French firms, the March 1972 Franco-German Protocol (or MOU) called for a special contribution of FFr25 million by the German government (some 10% of development costs) to the French government for the cost of development of the engine; a compromise finally being reached on this point. Responsibility for development of the Larzac engine was with a Groupement d' Interet Economique set up by the French firms Turbomeca and SNECMA in 1969, the Groupement Turbomeca—SNECMA (GRTS).

GRTS subcontracts production work on the engine to: its two co-owners, the two French firms SNECMA and Turbomeca which as of 1977 were to have 23% and 29.4% of the work respectively; two German firms, Klockner-Humboldt-Deutz (KHD) and Motoren und Turbinen-Union (MTU) which as of 1977 were to have some 22% and 22.6% of the production work respectively; plus another 3% to other firms, including Fabrique Nationale. At that time there was also the possibility that these percentages were to be modified somewhat to give KHD 25% and Fabrique Nationale 5%. Basically, Turbomeca will manufacture the engine cold section, and SNECMA and MTU, the hot section—there being no duplication of sub-assembly work in the manufacturing of the engine either. There are two assembly lines to produce the engines for the French and German aircraft, as well as all export orders (except for Belgium's) one at SNECMA's Corbeil facilities, the other at KHD's plant at Oberursel. The engines for the 33 Belgian aircraft are being assembled by Fabrique Nationale at Herstal. This latter work is being contracted for by the Belgian government.[199]

5. U.S. Industries Role

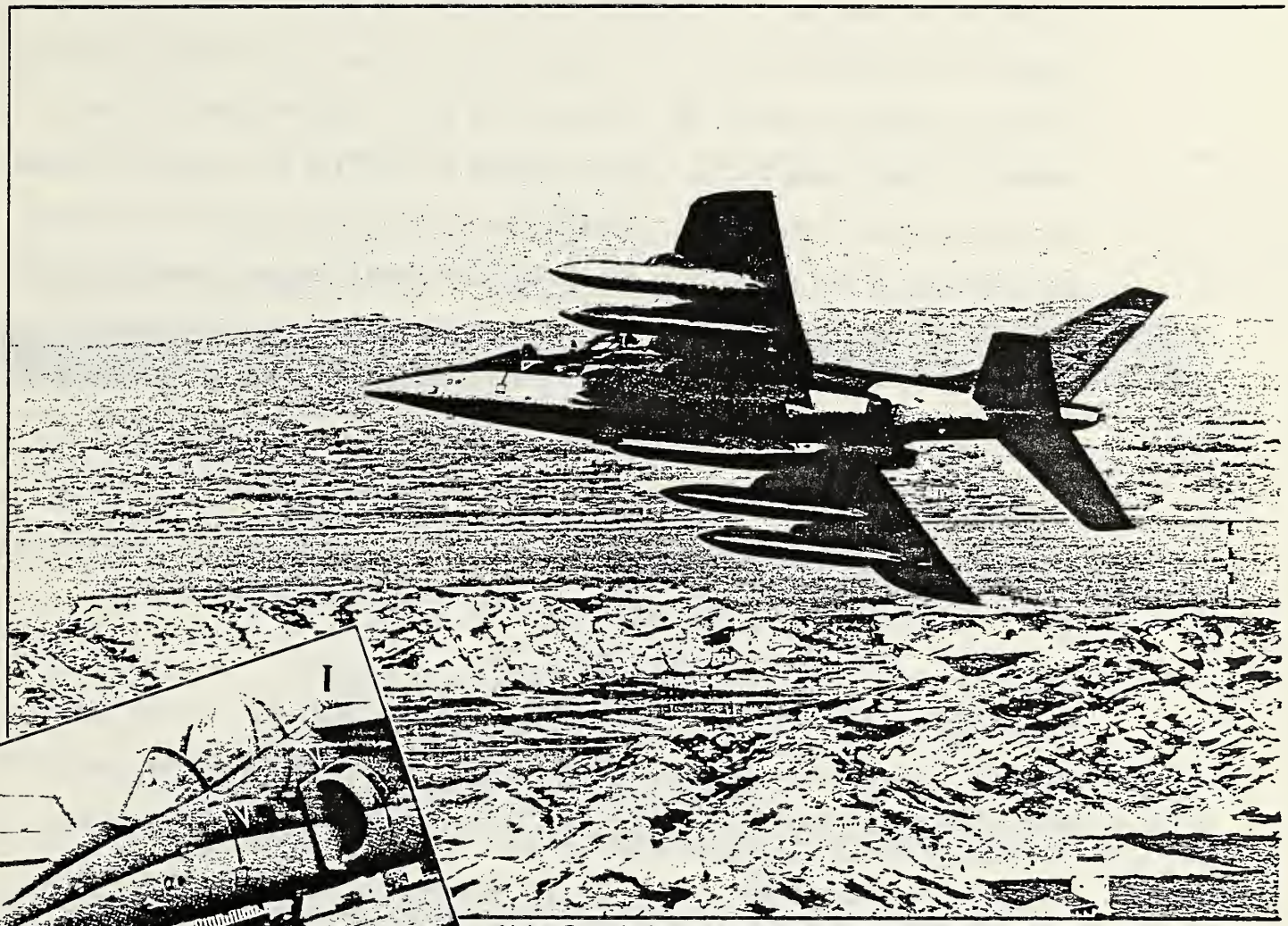
Among the other subcontractors—and representative of the role of U.S. industry in this, and most other collaboratively developed European systems are: Lear Siegler Instruments Division of Grand Rapids, Michigan, is furnishing its altitude Heading Reference System Model 6000, which also is similar to the unit installed in the Fairchild A-10A; the HUD was jointly developed/supplied by VDO Luftfahrtgerate Werk, Frankfurt, and Kaiser Aerospace and Electronics; and Rheinflugzeugbau GmbH of Bremen is producing under license from Stencel Aero Engineering Corp. of the U.S., the firm's S-3A ejection seat.

6. Export Sales

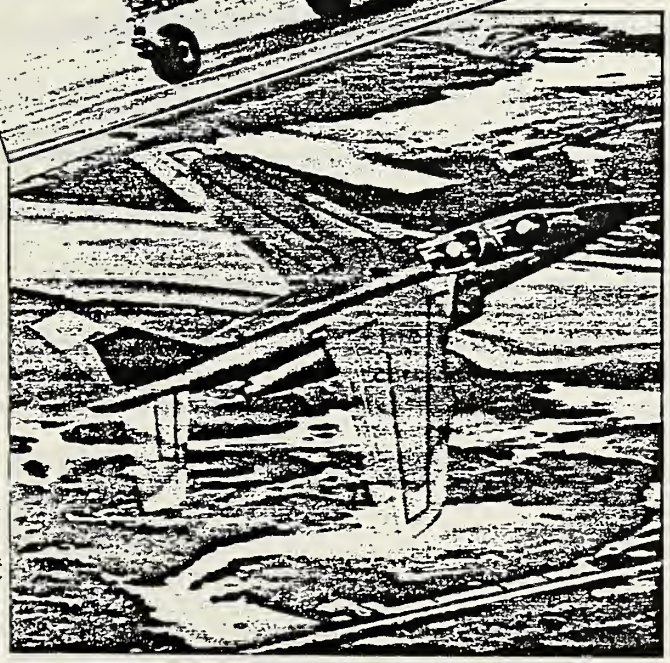
In line with the Franco-German production MOU export sales for the Alpha Jet are the responsibility of Dassault-Breguet. Although this is the basic rule, there is a gentlemen's agreement between the two firms allowing for Dornier's taking the lead in marketing to these countries where it has better relations. For the engine SNECMA is wholly responsible for export sales, buying the Larzac engine from the GRTS and then reselling it to the customer.

As of late 1980 Alpha Jet orders stood at 492. The order base was still at 200 each for France and the FRG, plus 33 for Belgium, 24 for Morocco, 12 each for the Ivory Coast and Nigeria, 6 for the Quatar and 5 for Togo. The Emirat of Abu Dhabi was at that time also in the midst of negotiations with Dassault over the purchase of the Alpha Jet.[200]

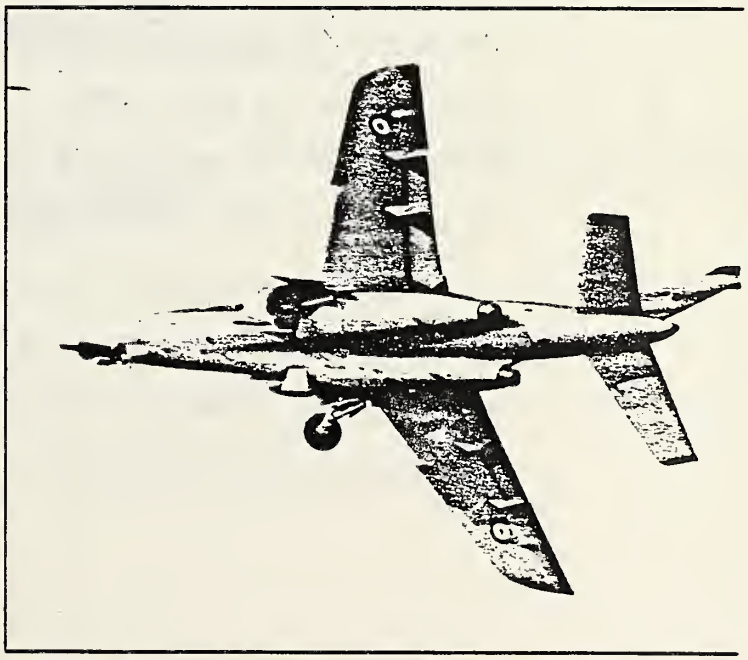
Militärluftfahrt: Angepaßter Alpha Jet für Afrika



Links: Rumpfspitze des Alpha Jet MS2. Oben: Ein MS2 mit vier Zusatzbehältern



Dieses Bild zeigt einen Alpha Jet MS2 bei einem Testflug



1984 wurde in Farnborough auch ein Alpha Jet MS2 vorgeführt

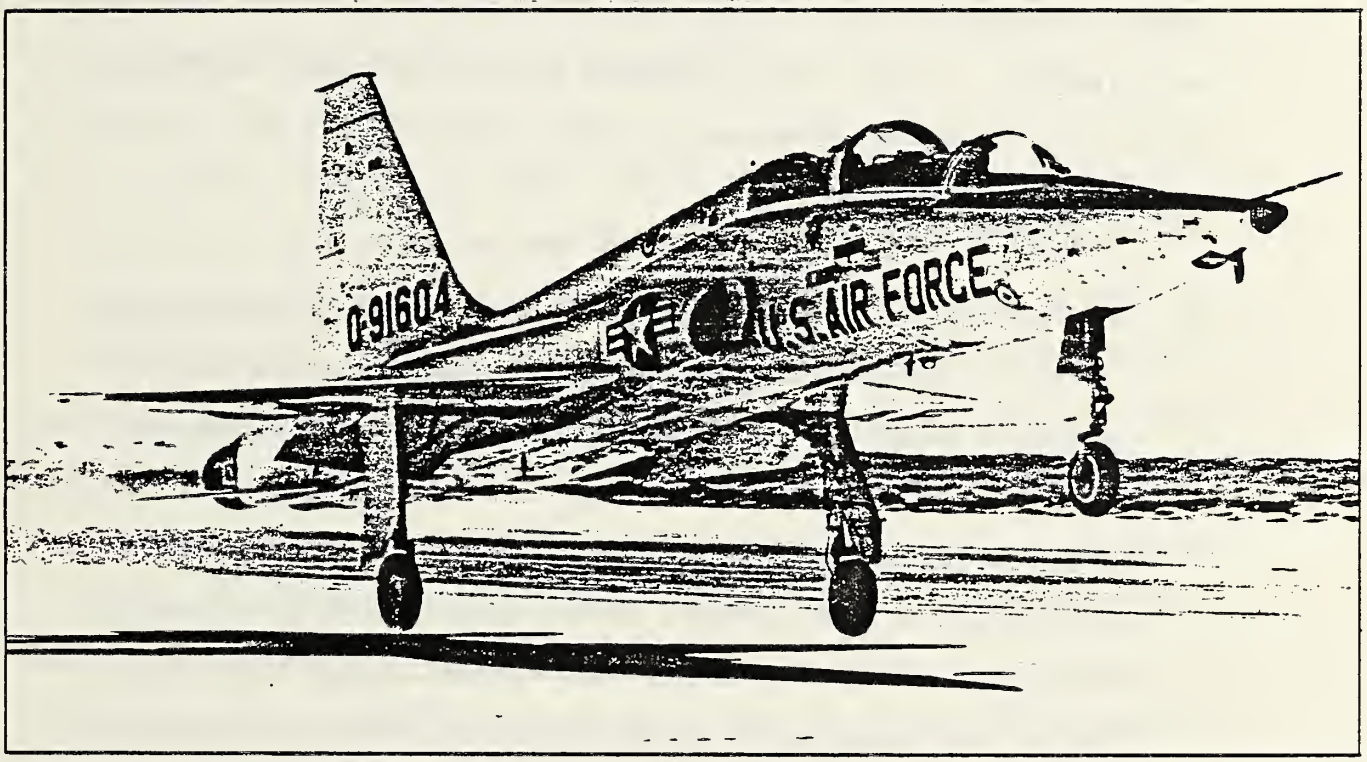
Fotos: Archiv (4), Redelmann

The Alpha Jet lost out to its chief competitor, the British Hawk, during a contest for some 50 aircraft in Finland in 1976. Due to the three year delay and rising costs the Alpha Jet forfeited its early lead and gave the Hawk a chance to remain competitive, with it ending up that the two planes were made available almost concurrently. A major deal pending as of mid-1979 involves the competition for a replacement trainer for the U.S. Navy (although having been knocked out of the running in early 1978, under DOD pressure the Navy reinstated it shortly thereafter in the intersts of the NATO RSI drive). This competition is covered in the following chapter. The German government has the lead in these negotiations, while Dassault-Brequet continues to act as prime contractor on behalf of both co-licensors. All industrial teams working with Lockheed are joint Dassault-Brequet and Dornier efforts.

Another major deal that fell through in early 1979 involved the Arab Organization for Industrialization's possible construction of some 160 Alpha Jets, in Egypt under license. The previous November, Dassault-Breguet and the Arab Organization for Industrialization (AOI) signed an accord covering licensed production of 160 Alpha Jets in Egypt. The AOI would have majority control of the jointly owned firm. The first Alpha Jets were expected off of the production line by the end of 1980. The same month the AOI signed an agreement in principle for the manufacture of 400 Larzac M49-04 engines which was scheduled to begin in 1979. Unfortunately, with the Saudi Arabia, Kuwaiti and UAE break with Egypt after the Egyptian-Israeli Camp David peace accords, the AOI fell apart and the arrangements were suspended. In late 1980, however, Iraq was evidently on the verge of picking up where the AOI had left off for license production, with a 150 aircraft order. (Iraq, which supplies France with 23.3%

Die bahnbrechenden Konstruktionen im Flugzeugbau

USA	10. April 1959	T-38A Talon



Northrop T-38A Talon

of its oil, started delivery in November 1980 of the first of its order of 60 Mirage F-1 fighters; the front end of a major Iraqui effort to break away from its over dependence on the USSR in the area of defense equipment).[201]

7. Conclusions

In spite of the Alpha Jet program's finding itself at the nexus of conflicting cross currents within the Alliance (more or less the fate of all such programs), which resulted in major delays, increased cost, and decreased competitiveness certain points that more than counterbalance these problems can be counted to the program's credit.

1) But first of all, following on the heels of the MRCA Tornado project history and covering the same time period, that of the Alpha Jet is especially useful for comparative purposes. Both the Tornado and Alpha Jet provide examples of different approaches to collaboration, from source selection all the way through to joint project management philosophies and contracting relationships. Similar to the Atlantic project, this involved a lighter, more streamlined, non-duplicative organization than that of the Tornado—be it a somewhat less equitable one—and standardization on the specifications, standards, and practices of one of the partner firms (as opposed to standardization through inter-firm agreement).

2) Secondly, France and the FRG have successfully developed, and are now producing along with a third NATO partner, Belgium, an excellent airplane that fulfills an important military requirement of each nation, while

supporting the further development of higher technology national industries and avoiding BOP disruptions. And as for NATO RSI, two versions of the Alpha Jet were developed and are being produced on a rational basis (i.e. involving minimal duplication) among the three NATO member states.

3) This project history also displays the necessity that the FRG feels to finely balance its defense acquisition relationships among its three major allies—the U.S., the U.K., and France—and how this tight rope walking/ juggling act can impact on a given project.

4) In addition, the original order base of 400 planes provided by the French and German governments has been maintained, despite the centrifugal pressures encountered (and thus facilitating access to the international market), while standardization was maintained as well vis-a-vis the basic airframe, equipment, and engines, with only specialized equipment differing. Having two versions of the aircraft however, has had the advantage of offering export customers wider options in their choice of equipment as well allowing France and the FRG greater flexibility in reconciling their differing arms export policies. In spite of the loss of some of its competitive edge, the system has gotten off to a good start and has excellent prospects for world-wide sales.

5) With regards to the close support version and its satisfying of the FRG's requirement specifically, unfavorable comparisons in its operational capabilities (especially vis-a-vis American systems) can be countered by an argument that manifests one of important constraints within which NATO

RSI must work - the need for specialization. The narrower limits of the German requirement allows for a system that conforms to the specific operational requirements of the Luftwaffe, while not going beyond them with otherwise unnecessary features that would be needed for U.S. planes tailored to greatly varying conditions all over the world (that would themselves require Germanization in the event of procurement by the FRG as happened with less than satisfactory results with the F-104G).

6) This project also offers another example of a successfully structured international competitive design selection process, wherein the customer governments were politically indifferent as to which Franco-German team was chosen, the Alpha Jet or the Eurotrainer.

7) Another significant aspect of this program that applies equally as well to the other programs discussed in this paper, but is nonetheless worth mentioning once again. Dassault-Breguet and Dornier have continued to develop their long term working relationship, one originally established during the NATO Atlantic Maritime patrol aircraft project, that is an important part of both firms transnational ties, one that will most likely prove to be a valuable asset for future programs—among these two or with other firms.

8) As one final comment, although this program is based on the optimization of industrial, economic and military interests of an Alliance sub-grouping of three nations and not the Alliance as a whole, this sort of intermediate

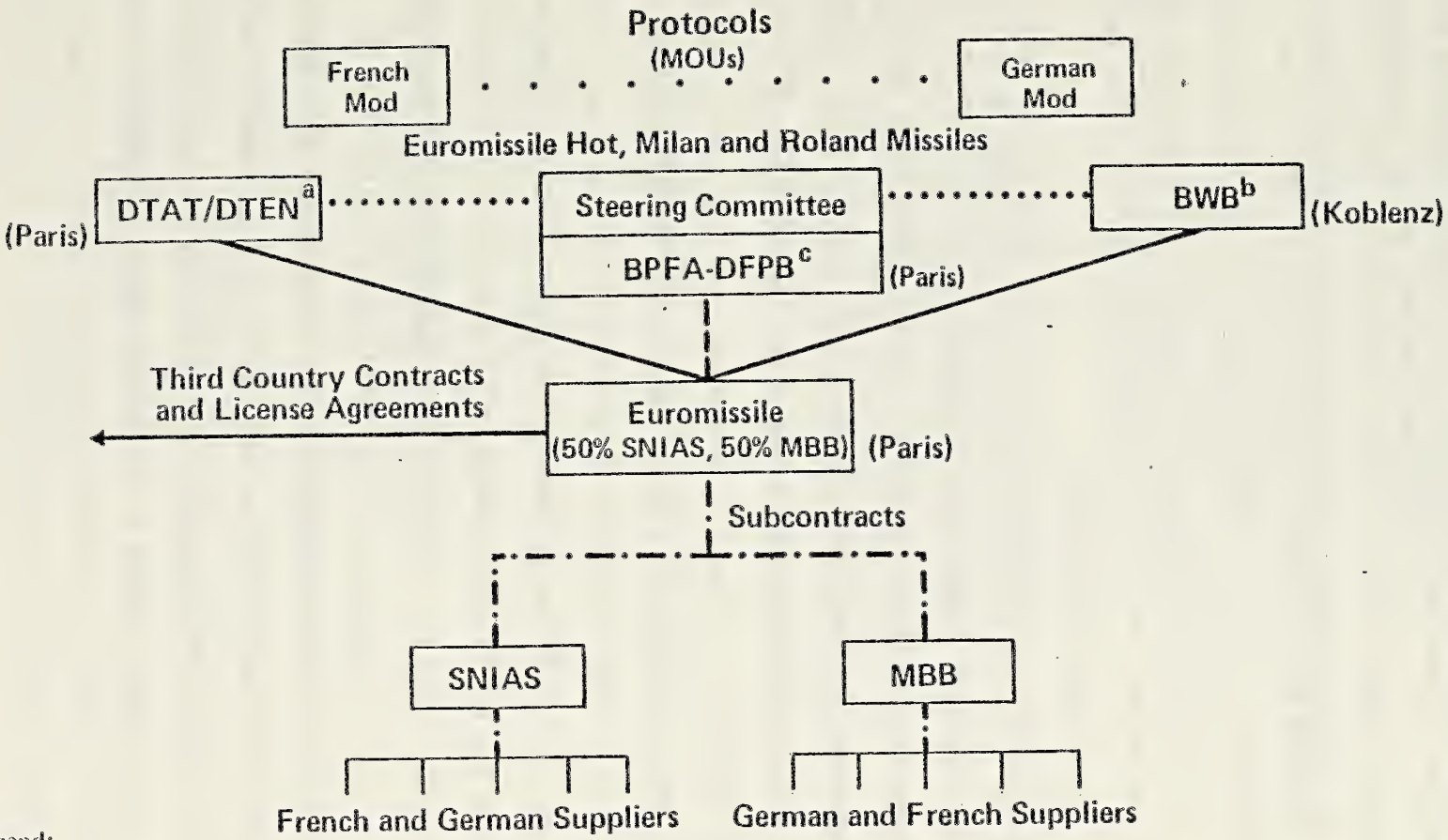
solution is representative of what the allies have found in the past to be feasible. This is also probably the sort of thing that the allies will have to settle for in the foreseeable future balanced by interoperability, although one can still see room for an enlargement of such subgroupings and a better orchestration among them.

six months depending on the specific project, and delegate most of their management and administrative tasks to one national governmental agency e.g. the approach of the Atlantic, Alphajet, Sea Sparrow, PHM, and the Tri-Partite Mine-Hunter projects). In fact, the BPFA could be a bit closer to the latter than to the former concept, except that each government now contracts directly with Euromissile on its own behalf.

One example of how the two governments go about the business of jointly administering the three programs is provided by the arrangements for contractor surveillance. In each of the two countries, the responsibility for contractor surveillance falls to the respective national quality assurance service: Service de la Surveillance Industrielle de l'Armament (SIAR) in Paris; and Bundesamt fuer Wehrtechnik and Beschaffung-Gueterpruefdienst (BWB-GP) in Koblenz. Those practices and procedures in use in each of the two countries pertaining to contractor surveillance are in general applicable within their respective frontiers for the three missile programs and are mutually recognized as valid. The two services have reached agreements for each system over procedures that allow each country to be assured that the raw materials, components, assemblies and equipments that it receives from the other country's industry will have satisfied the requirements of its surveillance service and conform with the technical specifications of the corresponding order.

At the April 8, 1975, meeting of the Franco-German Steering Committee a proposal of the BPFA, SIAR and BWB-GP recommending that a 'Groupe de Travail et Surveillance pour le System d'Arme Roland' (GTSR) be created was approved. The GTSR Working Group was commissioned to write up a mutually acceptable set

Three Franco-German Tactical Missiles



Legend:

- ..... Representation, coordination, and administrative support
- ———— Project management
- ———— Contracts
- — · — Subcontracts

Notes:

[a]Direction Technique des Armaments Terrestres (DTAT)/ Direction Technique des Engins (DTEN)

[b]Bundesamt fuer Wehrtechnik und Beschaffung (BWB)

[c]Bureau du Programme Franco-Allemand—Deutsche-Franzoesiche Programme Buero (BPFA—DFPB)

of documents for the implementation of the quality assurance procedures for the Roland program. The primary objectives of this Working Group as stated in its first document issued, later in April, and entitled "Surveillance des Fabrications du Systeme d'Arme Roland: Generalitees," (GTSR/1 Generalitees), were as follows:

a. Assuring the proper coordination and exchange of data between the two national surveillance services;
b. Reaching agreement on the modifications to be made to the normal national procedures that will take into consideration the requirements of the Roland program, and elaborating the documents that would define particular procedures for the surveillance of the program; (e.g. waivers and dealing with defective materiel both prior to and after delivery to the military users);
c. Settling those problems that may arise during implementation.

The meetings of the Working Group take place alternatively in the two nations; the chairmanship being filled by the chief of the national delegation in whose country the meeting occurs. The chairman is responsible for the organization and notification of the meeting, and of compiling and disseminating of the minutes. In addition to the representatives of the national surveillance services, the Working Group includes representatives of the BPFA, with the provision for the eventual representation of any other national government services involved in the program. The Working Group addresses its reports to

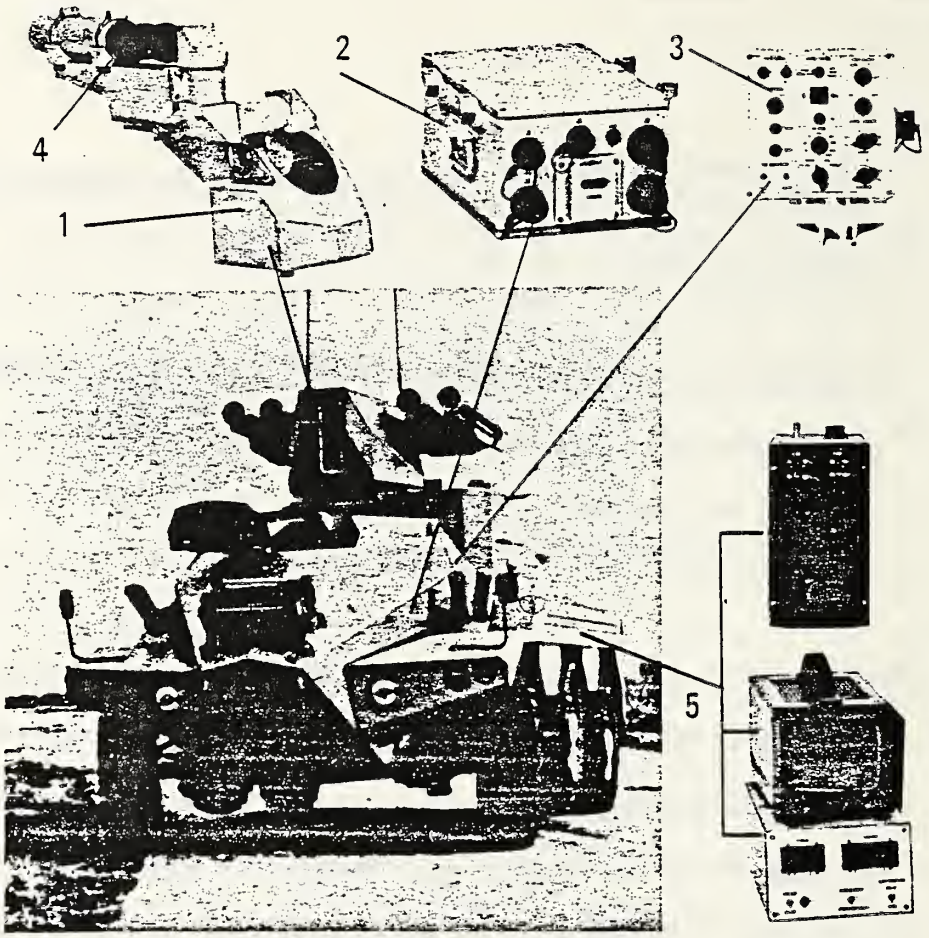
the BPFA, which in turn submits to the Steering Committee any problems that were not resolved at the Working Group level.

A similar working relationship and organization to that described above fore quality assurance applies for auditing costs. The two governmental agencies involved are the BWB for the FRG, and the Comite de Coordination des Services d'Enquetes de Prix (CCSEP) for France.

The BPFA is not responsible for exports. Euromissile is free to sell its hardware to all those countries for which an export certificate is approved by the French Government's Direction des Affaires Internationales (DAI).[202] As is commonly known, the two governments have diametrically opposed export policies, but evidently in this case the FRG has agreed to wash its hands of any responsibility over the destination of exports. There is however, a Franco-German agreement on the export of bilateral goods to non-NATO countries, the French Government having committed itself to the FRG to provide, information on pending export certificates.[203]

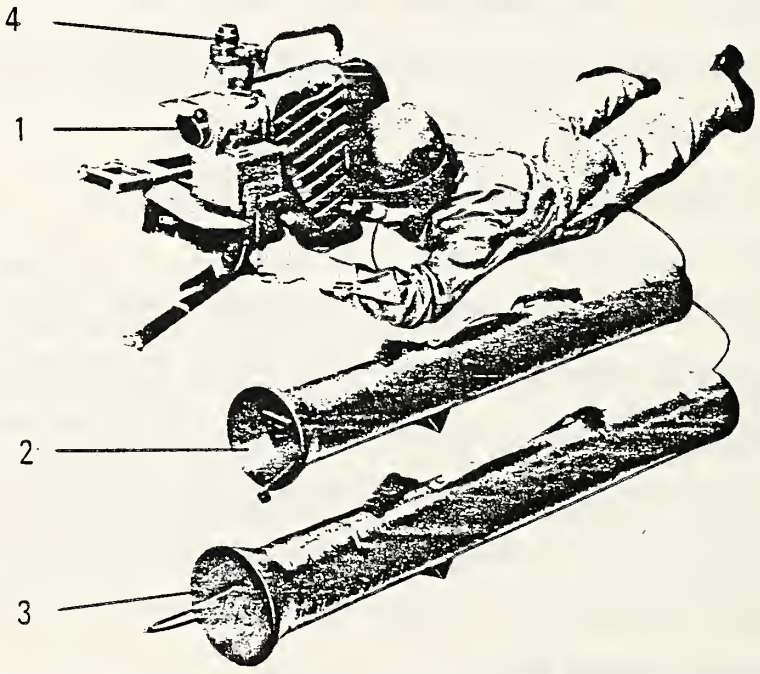
b. The Inter-industrial Organization

Euromissile is a Groupement d'Interet Economique (GIE) with the FRG's MBB and France's Aerospatiale each owning 50%. The Euromissile GIE was set up in 1972 under a French law, dating from 1967, which provides a legal framework for a merger of commercial activities but not of assets. Significantly enough, besides being a sales and marketing organization, as was its predecessor UVP,[204] Euromissile is also entrusted with the industrial management of on-going programs.[205]



DX 131 HOT missile simulator mounted on a SNIAS UTM800 turret (prototype). *Key:* 1—Optics unit; 2—Computer; 3—Control unit; 4—TV camera; 5—TV monitor, reticle generator and TV power supply. The UTM800 turret with its associated DX 131 simulator can be mounted on various vehicles. Photo shows Panhard's 6×6 VCR-TH.

Source: International Defense Review



DX 143 simulator for the *Milan* portable anti-tank missile. *Key:* 1—Optics unit; 2—Computer; 3—Power supply; 4—Instructor's sight (for checking purposes). The optics unit is mounted on the launcher in front of the IR tracker objective. Computer and power supply are fitted in the missile launch tubes, which can be used during field instruction to closely simulate in weight and volume the various portable components of the actual weapon system. The power supply is sufficient for 700 missile launches and an automatic charger is delivered with the simulator. The DX 143 has been adopted by the French, British and West German armies as well as those of several other countries.

The three missile projects began on a joint basis in 1964 between Boelkow[206] on the German side and Nord Aviation on the French side. Both entities were merged into the larger current firms over the second half of the 1960's as a result of their respective national government's policies of encouraging mergers for consolidation to improve international competitiveness. Nord Aviation was totally state owned as is Aerospatiale.

Euromissile employs about 90 people. As with Panavia for the Tornado project, the actual development and manufacturing work remains with the parent companies and is managed by them.[207] Euromissile's technical management responsibilities include: letting contracts to the parent companies, surveillance of schedules, and quality control. Euromissile also has responsibility for cost control but only serving in a secondary capacity, as overall costs are in any case checked by the respective governments.[208]

The three program managers at Aerospatiale and the three at MBB are Euromissile representatives as well. As of 1982 the French program manager takes the lead in two of the three programs, and the German in one. In each case the other firm's program manager wear's a deputy program manager's hat at Euromissile. These arrangements are credited with the rapid sorting out of technical changes and the rapid elimination of hitches in the program, since decisions made at Euromissile can be put into action almost immediately. According to the French law which governs GIE's, those GIE's with more than two members must recognize the majority vote. Decisions at Euromissile must be unanimous because of the 50-50 distribution of ownership among the two members.[209]

A four-man Board governs Euromissile. It is constituted by one representative from each of the parent firms' relevant divisions[210] as well as by Euromissile's two directors: its President (French) and its Vice-President (German). Directly subordinate to the company's directors are the program managers of MILAN, HOT and Roland, the Finance and Administration managers, and finally the two sales managers (one French, and one German) who run their operation as an integrated team. As with the program managers, the two sales managers wear two hats, holding the same position in their parent firms. This entails splitting the normal work week between the home offices and Euromissile. The Euromissile sales team has exclusive responsibility for the sale of Euromissile products to third countries, while sales negotiations with the FRG and France are carried out directly by the finance and administration departments.[211]

c. The Three Missile Systems

The HOT missile is a vehicle launched anti-tank missile and the MILAN, a man portable anti-tank missile.[212] The Roland I is a clear weather low-altitude surface-to-air missile system mounted on a tracked vehicle. Roland II is the more advanced all-weather version of the Roland. Development of the HOT cost some $50 million, the Milan $60 million, and the Roland I about $100 million. Low rate production for the HOT began in 1974, the Milan in 1973, and the Roland I in 1973.[213] French Army originally ordered the Roland I, while the Roland II was for the Bundeswehr and the Luftwaffe (The French Air Force adopted the Thomson-CSF Crotale instead). By early 1977 over 20,000 Milan missiles had been delivered to some 13 NATO and non-NATO countries and the HOT

had been sold to eight countries.[214] An American version of the Roland II, the U.S. Roland, entered low-rate production in the summer of 1979, being produced jointly by Euromissile's two U.S. licensee's, Hughes and Boeing.

The Roland II has been one of the few major European developed weapons systems to penetrate the U.S. market. This project history is treated in Chapter 9 (Mode #4). Another Euromissile system has also been produced under license, the Milan. The British procured an initial small batch of the Milan anti-tank missiles off the Euromissile line for immediate service with the British Army of the Rhine, with the remaining systems to be manufactured in quantity under license by British Aerospace (Mode #1).

One interesting point encountered in the literature covered pertaining to the MILAN project was made by Doctor L. Boelkow. He cited the MILAN as an example in emphasizing the importance of having a well defined project from the start. Between 1 and 2 years of development time were lost because France wanted a missile fired from shoulder height, and the FRG wanted a ground fired one while development had already started, the definition phase being completed.[215]

2. Contract Management

The following section is translated from a paper presented by Jacques Sorlet, Euromissile's Finance and Contracts Manager, in Brussels at NATO's January 1982 Symposium on Multi-national Program Management

The paper was entitled "Les Achats Publics d'Armement en Cooperation."

a. Background Facts

To fully understand the framework and difficulties involved in managing procurement of cooperatively manufactured products, one needs to first examine the framework of the negotiation processes and the divergent interests involved, in light of the evolutionary dynamics of both.

This clarification is necessary to appreciate the trends perpetually facing the buyer, and effecting the program performance. The fundamental fact is that the government procurement agent, with hardly an exception, has his hands tied throughout the life of the program.

At the outset the following were the parties involved with the HOT, MILAN and Roland programs: representing the German government, was the Bundesamt fuer Wehrtechnik und Beschaffung (BWB), a purely administrative agency, with no industrial exposure; and for France, Direction Technique des Aarmements Terrestres (DTAT), a multi-function body with industrial responsibilities, often competing directly with private companies. To complicate things, while

France was a traditional exporter, the German reticence in international markets has been a touchy issue to overcome.

On the industrial side, there was the German firm Boelkow, a privately owned, promising, but young company, joint-venturing with the French State-owned Nord Aviation, mature, but beset with low-profit or money-loosing programs. Compounding the problems was the goal of integrated production, which implied a free transfer of materiel, talent, and ideas in support of a single production line.

On the management end, the rather liberal German system had to be intermeshed with the French authoritarian style rooted in the virtually monopolistic position of the French aerospace establishment.

Despite these apparent contradictions, and numerous visitudes they had to overcome, the programs succeed after all, attesting to the basic viability of methods employed.

To minimize delays resulting from the search for reconciliation between divergent national structures, in 1969, buffer organizations were created as platforms for discussions on an equal basis, i.e., with no party in eminence.

Thus, on the government level BPFA (Bureau des Programmes Franco-Allemands) was formed, and on the industrial level, UVP/Euromissile, each complementing the other. Both bodies form the nucleus of cooperation, coordinate problems

and recommend solutions for submitting to the governmental Directorate Committees or Industrial Boards of Directors, as the case may be.

b. Methods Used and Associated Encumbrances

Concerning contracts and business relations, it was decided to initially designate the French DTAT as the executive agency—which largely limited the regulatory powers of BPFA and consequently, made it incapable of settling expeditiously inter-company differences. (It was found impractical to nominate BPFA as the executive body). DTAT awarded the contracts to the industrial contractors (originally Nord-Aviation, later SNIAS, then Euromissile) in conformance with French procedural directives of the Directorate Committee.

The contract formats, based on French law, were rewritten so as to juxtapose rather than combine different national texts. At the outset, the emphasis was on assuring continuity or existence of the programs rather than on innovating (e.g. contractual provisions).

Thus, a mutual agreement "in principle" with a pre-selected contractor would form the basis of the contract, to avoid impeding the technical progress by competitive bidding or by attempts to resolve future problems before they occur.

The question then arose as to what procurement policies to select from the arsenal of regulations existing in both countries.

(1) Controlled Expenses

Practically all R&D contracts came under the category of controlled expenses. Each Government would audit the invoiced costs, and with no other controls available, each program manager would in fact adapt his program to the budget allowance. Such purchasing policy was nevertheless justified by the extreme fragility of the three programs in the start-up stage and the haphazard, often arbitrary allocation of government funds.

The results have not been overly brilliant. Significant overruns became common everywhere, and absence of such firm requirements as financial discipline led to lax financial controls.

In addition, at least at the start, representatives of the respective governments had been somewhat mistrustful of one another, fearing an imminent competitive situation between both nations; which did not help the initial negotiation process.

(2) Fixed Price Contracts

Once past the R&D stages, on both the German and French side, a fixed price contract policy was developed. In principle this represented progress, but would often miss its point, sometimes due to rigidity, at other times because of over hasty application. In retrospect, it has become a new gamble.

It has led to more aggravating frustrations than the old system. It called for the manufacturer to commit prices and deliveries of production hardware prior to defining design and performance specifications, design and fabrication of tooling, and construction of a test prototype for qualification. Consequently, by forcing up-on the contractors the fixed price and schedule terms, the customer agencies had deluded themselves into defeating the reality of both.

(3) Provisional Ceiling Pricing

Faced with those new difficulties, the buyers devised a third policy, provisional price ceiling, subject to an audit.

However, this latest system stumbled on hurdles no smaller than the previous two. The German auditor under the German regulations, was already in place to handle all elements involved. By contract, the French investigator's capability was limited to inspection of accounting records. A two-fold difficulty followed:

1. The customer saw sizeable funds (representing the difference between final price and provisional price) frozen for an extended period (some years), instead of using them more productively.
2. The contractor received final payment way past the completion of the program, i.e., after all the contingency figures were in (taxes, exchange rates, adjustments).

(4) Fixed/Adjustable Prices and Advance Pricing

The Fixed/Adjustable price contract, based on German regulations, has the advantage of reducing the period needed for determination of the final price by auditing costs ahead of the closing of the books. Advantages of this method come close to those of Advance Price contracts (where all pricing parameters can be predetermined), but though considerable, they have lost munch punch due to the following shortcomings.

In France, the time-saving advantage was watered down through tradition-bound attitudes of the auditing personnel. In addition, not unlike with the provisional ceiling methods, a greater range of competance is required of auditors. After all, having completed inspection of accounting records, why should auditors risk attempts to comprehend, verify and negotiate the contract?

In has become clear that the rigidity of Advance Contract is ill suited for the vagaries of the HOT/MILAN/Roland programs which have been in constant turmoil and subjected to corresponding contractual alterations.

Consequently, contracts prepared with much time and effort become more of a liability than a benefit. By not reflecting realities of implementation they imply financial consequences surprising to both the buyer and seller, and later adjustment of clauses to the facts of life proved more time-consuming than writing a new contract.

To avoid these difficulties on other programs stratifying contracts item by item was resorted to with fixed prices based on improvement curves.

Next, the problem of delays in contract release was addressed. In fact the normal course (price determination, Directorate's approval, preparation of Commission's report, signature routings) had been taking so long that the contractor suffered where his own payments and purchases were involved.

To summarize, practically all cooperative procurement methods employed to date, though satisfactory in the gross sense, have also had some undesirable side effects.

c. Analysis of the Causes of Difficulties in Franco-German Cooperative Ventures

The cooperative arrangements certainly leave much to be desired. Some reasons for the difficulties follow:

- The need for an intergovernmental agreement to start cooperative production is a frequent cause of tardiness on political grounds.
- Contract approval routing through the respective channels: preparation by a bilateral body, processing by government agencies, endorsement by the Directorate, and lastly by all national controlling agencies.
- Incompatibility between governmental and industrial accounting procedures: handling of currency conversions, varying exchange rates and associated risks, and cash management.

- Lengthy price determination process: all cost audits in the partner country have to be done by the respective national agency, conclusions reported in writing and signed-off by all authorities involved.

- Differences between national customs and procedures: CCAG's vs. ABBV's, French vs. German pricing regulations; every problem resolution is tedious and time consuming, since the French contracting agencies responsible for decisions are neither aware of, nor are willing, to recognize the contradictions.
- Bureaucratic inertia: paperwork flow, at times criss's-crossing, is long, slow and impeded by often's excessive lack of confidence on all levels.
- Excessive inter-service mistrust or unjustified's rivalry for petty achievements.
- Incompatibility of the national policy directives for buyers with the coopertive's procurement policies.
- Absence of specific bi-national coordination rules relative to procurement of cooperative products.
- Inadaptability's of national regulations to problems posed by cooperation and unwillingness to waive the rules.
- Instituting of cooperation rules unfavorable to private industry, like for example, the burdensome 50/50 sharing requirement.

d. Suggestions for Improvement

As explained above, the government buyer in a cooperative program is facing numerous obstacles. What advise should we offer him to lessen these

difficulties, while partly safeguarding private or national companies from unavoidable sacrificial entanglement in the bureaucratic web?

(1) Above all, observe, as an absolute mandate, the contract validation dates. Don't substitute contract/purchase order release with promises. Release contracts no later than the scheduled work start date. This simple rule is often forgotten and our British friends in particular complain about such inadmissible laxity.

We have already talked about obstacles that get in the way of living up to this rule (shortage of funds, contract complexities, etc.). Have a preliminary funding authorization contract devised to enable the start of the project while final negotiations are still under way, either as an open-ended agreement, or in the case of R&D, covering a number of hours allowed; such a contract should be issued by the very organization responsible for negotiations (e.g. BPFA▪).

(2) Make the government buyer responsible and liable for the contract. He should be a professional who does not pass the buck to experts or price negotiators. He should be capable of negotiating the contract in its entirety, and know its details to the point of defending it before an auditing commission, in the event of an investigation.

Such a charter would preclude the eternal running in circles, travels across the border, and waste of time. The international buyer or buying team (such organization should be created, only infrequently is it given

a token thought) should have powers to decide on the price of hardware and payments in a documented meeting.

If such a team is mixed, there is a need to follow national inquiry procedures and a task-force approach to occasional meetings, without sliding from this systematic and quiet approach back to the dust pan of a neglectful negotiator.

(3) Establish, finally an atmosphere of trust between the manufacturers and government agencies. That's where the British shine with daily examples.

With no mutual suspicion between government bodies and industrial concerns, they form a sacred union abroad in both business and private capacities.

Who is negotiating intergovernmental agreements in the United Kingdom? This very amalgamation, which instead of confronting each other, unite and win.

Why waste energy on redundant efforts in questioning the manufacturer's offer or word? Why not extend to him the benefit of the doubt and trust at least once, at his risk - that is, with him understanding that only he would bear the consequences of deception (and the pain of the fall).

(4) As for the Institutions?

Above all, avoid the so-called unified codes; no nation involved easily swallows extra, or supra-national rules applicable within their own jurisdictions. The cooperative programs should not become test benches for such attempts.

Instead, recommend, a bit of flexibility and awareness of the real problems, to contracting authorities. The Contracting Commission, once familiar with German pricing rules would, for example, retain the formula for penalty ceiling and also allow for advance payments upon contract award. The Commission would then be in a better position to appreciate those proposed clauses derived from French regulations which will often be fully applied to the German or British firms.

It should be remembered that in cooperative ventures, one does not expect foreign partners to work on the basis of non-verifiable fixed price contracts as in the case of sales to third nation customers.

Don't reform, but inform!

(5) Rather than creating complex appeal strata, why not institute a mediator, an "ombudsman", like in many other areas of public affairs. It can be an official, who outside of his mediating function, would be in the position of dispensing drops of lubricant where and when necessary, on all bureaucratic levels (Direction des Affaires Internationale (DAI), DSF,

Direction Technique des Engins (DTEN), SCC, Direction Generale Industrielle (DGI), etc.).

The multitude of government and industrial offices, well meaning, but short-sighted, often hold up the process for up to six months for the lack of a single piece of information with no head for real world consequences of such intervention.

Understand and respect the spirit of cooperation!

e. Other Aspects of Cooperative Ventures Often Misunderstood by the Buyer

(1) Export is an important subject, often glossed over silently either by design, or owing to communication difficulties resulting from the compartementalization of the agencies involved.

In cooperative relationships, a buyer one day often becomes a seller the next. The private sector and government who have for so long debated public purchases under commercial (private) law, discover themselves on the same side of the fence when confronting foreign customers, and work together. At such a juncture, the mutual confidence referred to above is no longer a wish but a reality born of expediency.

It should be remembered that for two out of three of the large Franco/German programs, more than 50% of production is exported. Nations who have funded R&D costs should proportionately profit from these export

contracts. Only a close government/industry collaboration can credibility support the offered terms of sale.

(2) Confidentiality is an often overlooked correlary of such collaboration.

On the inter-government level, France and the FRG have succeeded in injecting a climate of trust into the groups working currently on common programs, which is evident particularily at the program level.

After the completion of detailed negotiations, all information relative to prices, schedules, methods, and technology are freely exchanged and discussed with no regard to nationality and without distrust. The same should apply to the individual government officials involved in administering the contracts.

However, although this free exchange is the normal outcome of agreements, it must not be indiscriminately extended to third country customers, even the friendly ones (e.g., NATO members).

The Franco-German block must retain its working unity of purpose within the framework of international relations, lest the fruits of cooperation be dissipated or diminished with benefit to no one. This does not imply that they should not be extended to other nations. But it should be done on equitable terms and with the concurrence of all parties involved.

All too often, in the name of grand ideas, these simple principles are being forgotten.

(3) To conclude, the last point concerns the term "Manufacturer" as it is used by Government procurement agencies. Based on the vicissitudes described above and experience accumulated with time, it was decided to create product line oriented individual European groupings (air-to-ground missiles, Euromissile, EMDG), set-up to receive and execute production contracts. Rooted in the cross currents of tradition, a number of misunderstandings have cropped up as to the true nature and role of individual groupings. In particular, an apparent temptation is to treat them as manufacturers, something they have never been meant to be.

Typically a grouping has no production function (tooling, shop manpower, receiving facilities, etc.)

All work done in its name is performed by member companies or their subcontractors. Its role is limited to promotion, sales and coordination, and in no way substitutes for that of a producer. This does not preclude it from direct subcontracting or otherwise disbursing of funds, as long as it is outside of the member companies' scope of work. This restriction is not to limit the grouping's authority, which is meant only to intervene in computation of prices, contract negotiations, and to secure, as far as possible, an equal treatment of manufacturers in both nations and to prevent members from unfairly outbidding each other.

f. Summary

In summary, despite the intentionally pessimistic tone of this presentation, it must be admitted that the results are there. All three cooperative programs have survived all tests; the shake-down phase of cooperation, the throes of uncertainty, and the red tape morass, to finally become a commercial success. Admittedly, sound technical concepts proved decisive, but much credit must be given to the good will of all those involved in overcoming the problems described in this outline. The last wish is that the experience gained over the last 15 years be put to productive use, and that these remarks do not end up as a voice crying in the wilderness.

3. Work Sharing -The Case of the Roland Program

Of the three programs within the Euromissile family, the Roland surface to air missile (SAM) system is the one that has had the highest visibility since the mid 70's, due to our own U.S. efforts to set up a production base for the system on this side of the Atlantic. (The project history of the U.S. Roland is detailed in Chapter Nine). Moreover, one american in particular, the author, having worked on the U.S. Roland program, was able to gain a glimpse of the European program through discussion with Euromissile colleagues Bruno Didelot and Jacques Sorlet. Also, a more detailed understanding was obtained through the day to day working relationship associated with hardware procurement from the licensor, involving Euromissile's Pierre Bueno and Ursula Speidel, plus Boeing's Paris rep for the U.S. Roland, Otto Langer.

The major problems experienced by the Roland program, more or less similar to all other interallied programs, could be grouped under the following four inter-related general headings: (1) two very soverign nations trying to jointly run a program and manage a contract, each with their own highly institutionalized defense acquisition systems (see Sorlet's discussion of this in the preceding section for all three programs); (2) maintaining an optimal amount of configuration commonality, i.e., degrees of de-standardization temporized by interchangeability; (3) Third country sales, this is usually tied up with extra-NATO sales in a highly politicized world market characterized by governmental instability and degrees of institutionalized brutality-in the case of the Roland however, this area of concern took on a particular twist with the landing of one clean, but very big NATO fish up front, the U.S. Army; (4) sharing work on the basis of juste retour; allotting tasks and jobs in line with the national investment ratio and the need to distribute (and periodically redistribute) work in as cost-effective a manner as possible against a rather fluid baseline.

a. Configuration Commonality

Standardization is rarely an absolute in the defense business or elsewhere. Once a weapon system is introduced into the inventory of a given national armed service, multiple configurations surface almost immediately. Designs for high technology systems are highly unstable in the early period of their lives as performance and other bugs are worked out. This is true no matter where the lines are drawn vis-a-vis engineering developmental/evaluation units, pilot/prototype units, pre-production, low rate production, and series

production. Then improvement programs are inevitably introduced at some point as technical blocks, slices, or "tranches", in order to upgrade the original production configuration over an extended period for the usual performance, reliability, or maintenance reasons. And eventually some of the older units where an upgrade is less feasible will be spun off for the use of reservists, training or provided to less affluent allies. Consequently, there will be multiple configurations in a given service's inventory at almost any point in time.

To further complicate matters a given system will often need variants tailored to one or more missions for the originating armed service or another service of the same national armed forces.

Then one introduces an allied armed service somewhere along the line in the system's life cycle. Here, with the Roland, the FRG and France merged their independent national design efforts to meet their individual assessments of the threat in the mid-60's. Subsequently the U.S. entered the picture in the mid-70's as the multiple European configurations were just beginning to settle down for series production (more on this in the next subsection, and in Chapter 9 where the U.S. Roland project history is covered).

As for France and the FRG's joint design and development program spanning the decade from the mid-60's to the mid-70's, a major divergence of views surfaced several years into the effort. The FRG had a more rigorous view of the requirement, judging that it needed an all-weather system, the Roland II, to deal with the weather conditions prevailing up on the front lines of Central

Europe for the Bundeswehr, and the air bases to the immediate rear for the Luftwaffe. France, with only its army involved, concluded that it could make do with a less expensive low altitude mobile air defense system limited to day-time , clear weather operations - the original configuration, the Roland I.

Note that the French Air Force for its part was well along, with contractors Thomson-CSF and Matra, toward independently developing a somewhat less mobile but longer range all-weather system, the Crotale. Through out this 10 year period, time (and again money) was lost due to the need to keep the two divergent configurations in sync, i.e., constant vigilance and difficult compromises were called for to maintain interchangeability between the components and subsystem of the two nation's variants, as changes in one evolving design impacted the other. And then the U.S. came along.

b. Third Country Sales - the U.S. Buy

The first foreign customer to select the Franco-German Roland was the U.S. Army. After its Short Range Air Defense (SHORAD) requirement resurfaced in the early 1970's, the U.S. Army evaluated three existing European air defense systems as alternatives to an independent U.S. R&D effort to fill the requirement: The British Aerospace Rapier, the Thomson-CSF/Matra Crotale and the Euromissile Roland II. Following demonstrations in the U.S. in 1972 and 1973, the U.S. Army organized a formal competition in 1974. Though this was associated with U.S. efforts to respond to Europeans demands for more of a 'two-way street', an off-the-shelf buy was not in the cards. Considering the scope of the planned U.S. buy it was decided that an economical production

line could be set up in the U.S. Consequently, U.S. industrial teams signed license agreements with the European designers of the three systems and submitted proposals to the U.S. Army. Ford Aerospace also submitted a proposal for the development of an all weather version of its existing clear-weather SAM system. The Roland II, proposed by a team comprised of the Hughes Aircraft Company (HAC) and the Boeing Aerospace Company (BAC) was selected in January, 1975.

The first significant consequence of the U.S. interest in the system was to breathe life back into a moribund program. At this time due to the not unusual array of technical, cost, and schedule problems the FRG was on the verge of jumping ship. Disaster loomed, for the fourth time in the project's history it appeared to be dead. However, when the U.S. apeared on the horizon and ultimately came up along side, the Germans took heart and decided to persevere. Though the project was once again saved, this was to lead to further navigational problems down stream.

The second major impact on Euromissile's Roland program stemmed from the U.S. Army's having obtained later during 1975 a better understanding of what it was actually buying. In the meantime Euromissile had transferred the technical data package to the U.S. contractor team which was converting it and preparing to build five Roland II Technology Transfer, Fabrication and Test (TTF&T) fire units along with missiles for test firing, prior to launching into a full scale production program.

Consequently, the program was restructured in 1976 to better reflect the U.S. Army's requirements. At this juncture a third; "Americanized" variant emerged, designated the U.S. Roland. A tri-national Joint Roland Control Committee (JRCC) was set up to coordinate the growth of the three ever evolving configurations. The first major U.S. inspired change in the Euromissile systems to come out of this was the switch from an analog command computer to a more reliable digital one. The two European nations agreed to go along and MBB began to develop one (to be incorporated by retrofit or in line) at a later date. Other changes flowing back from the U.S. were to follow.

Over the next five years of annual waffling exercises involving conflicting budgetary priorities between the U.S. Army, Congress and the Secretaries of Defense spanning the Ford, Carter, and Reagan administrations, the U.S. Roland program managed to survive. This five year period saw the development of a solid working relationship among the four firms (and their three variants), as the U.S. geared up to produce the system on a large scale. Finally in September 1981 the ax fell, terminating the U.S. program two years into low rate production (LRP) and several weeks before delivery of the first production fire unit. In the end the U.S. Army agreed to the completion of 27 of the 38 (LRP) fire units under contract, plus 595 missiles. These were to be transferred to a newly created National Guard air defense batallion.

The impact of this U.S. decision was three fold: (1) The tri-lateral improvement program spearheaded by the U.S. was now defunct; (2) The third

country sales effort had to be redistributed; (3) The U.S. was to ultimately obtain Roland II's off-the-shelf through a barter agreement with the FRG.

The tri-lateral product improvement program, CRG 2000, was torpedoed. CRG 2000 upgrade under development in the U.S. was intended to counter the evolving electronic warfare threat in Central Europe. France and the FRG had been depending upon this flow back of technology from the U.S. to upgrade their systems in the mid-80's.

The third country sales issue centered on the usual sales territory allotted to the licensee that accompanies its purchase of the licensor's technical data package and rights. The U.S co-licensees, HAC and BAC, along with the Army, were in various stages of nurturing along a number of sales prospects. Some were tepid, some warm and one was hot, Norway. Not only had the U.S. Army now disowned the system (the U.S. Roland's were to be transferred to the New Mexico National Guard), but the on-going low rate of production meant that unit costs for anything off the U.S. line would be prohibitive. The disengagement of the U.S. from the purchased sales territory and its transfer back to Euromissile took time to renegotiate, disrupting Roland sales prospects in the interim.

The third major result of the U.S. Army's termination of the production of its own Roland system came several years later with the procurement of Roland II's off the German production line in 1984 for U.S. requirements in Central Europe. This involved the dormant yet still open U.S.A.F. Europe requirement for defense of its air bases. The USAFE requirement was covered by a U.S.

Government-FRG barter agreement involving the U.S. Army's providing the FRG with its advanced high altitude Patriot SAM system in return for the Luftwaffe's agreeing to procure and man Roland II's to defend USAFE air bases.

c. Work Sharing

Sharing of the investment costs and risks associated with the development of a weapon system simply makes sense. But then distribution over time of the major benefits of the effort in an equitable manner such as the jobs, know how, technology and foreign exchange, is not a straight forward task. A fair return, or more often referred to as 'juste retour', involves more than recouping enough money to help offset the original outlay for 'non-productive' defense capital goods. As a general rule the even shouldering of R&D expenses is usually followed by a readjustment of work distribuition more in line with the actual rates of individual national orders for systems off the production line. Naturally there is often a substantial variance between actual orders and that of the original programming. Stretch outs, temporary but indefinite order reductions, exchange rate fluctuations, various national configurations, and sharing third country sales makes it a rather tenuous exercise to extrapolate on at any given point in time.

For starters, cost, work and responsibility sharing by the Euromissile team involved no inter-project trade-offs, unlike the Anglo-French helicopter projects (Puma, Gazelle and Lynx). Each of the three Euromissile projects stood on its own.

Over the 1958 to 1961 timeframe Boelkow and Nord-Aviation were each independently involved in low-level pre-feasibility studies for their respective MOD's aimed at the development of a low-altitude SAM system. In the FRG this military technical requirement was designated Projekt #250 (P250) and in France it was designated 'sol-air basse-altitude' (SABA). In 1962 the two firms teamed up combining their respective technical efforts to further pursue the SABA requirement.

In 1964 following the signature of an intergovernmental protocol, the French MOD's Direction Technique des Armements Terrestres (DTAT) awarded a contract on behalf of itself and the FRG to Nord-Aviation. This was for Phase I of a project to design and develop and test four prototype fire units of a SAM system, now called the Roland, and 40 missiles. The designated German industrial partner, Boelkow was tied in contractually through a subcontract placed by Nord-Aviation. In 1967, with the beginning of Phase 2, the FRG was forced after prolonged negotiations to proceed unilaterally with the funding of the development of an all-weather version of the system—the Roland II. The French government would not contribute financially at this time because it judged the development of the enhanced capability to be too expensive. Note that, though Boelkow was naturally given responsibility for this variant (be it under subcontract to Nor-Aviation), 90% of the design and development work had to be devolved to the only firm in either country with prior experience in this area, France's Thomson-CSF.

This switching of tracks involved a substantial loss of time during Phase II. What had now become the French version with optical sighting only, had to be

slowed down to keep its configuration in sync with the belated parallel development of the Thomson-CSF track radar for the German variant. This naturally also involved a substantial deversion of the limited financial resources that either country could allocate to the project. Eight fire units and 80 missiles were to be built and evaluated. Nord-Aviation/SNIAS still acted as prime contractor for both variants to the French MOD's DTAT.

With the start of Phase III in 1970, the French government finally reversed its prior stand and opted to participate in the further development and evaluation of the all-weather version. Phase III involved another seven fire units plus 285 missiles, and tooling up for pre-series/low rate production.

By this time program complexity had evolved to such a stage (along with Euromissile's two other projects involving anti-tank systems) that, in order to resolve the plethora of inter-governmental problems (e.g. German insistance on competition), a new organization needed to be established. The previously mentioned Bureau du Programme Franco-Allemand (BPFA) was set up in Paris at this time to handle the three projects. This helped overcome, but by no means abolished, many of the problems the program had to labor under in the decision making area at the inter-governmental level. Since 1965 the intergovernmental machinery had included a specialized team with hands-on responsibility, reporting to a technical commission, which in turn differed to a steering committee which met only twice a year.

Likewise at the industrial level the 50:50 joint venture, Euromissile, was set up by the two firms (Nord-Aviation and Boelkow having since been merged into

the new national entities SNIAS and MBB between 1968 and 1970). Contracts from that point on were placed individually by the two governments with Euromissile, which in turn placed two contracts with its two co-owners, SNIAS and MBB for their respective responsibilities.

Through this period Euromissile continued to have trouble filling gaps and maintaining continuity for the program with its on again/off again, slow down/speed up cycles. Stretch outs due to technical and funding problems strung Phase III out into 1975. The pre-series production contracts had in the interim been awarded in 1973. As previously mentioned, the recent interest shown by the U.S. Army had been critical to the FRG's decision to continue funding the project at this point. This kicked off Tranche 1a for the prodcution of 100 fire units and 2,000 missiles. (For SNIAS this entailed the transfer of produciton from its Chatillon facility in the southern suburbs of Paris to Bourges in central France). Under provisioning for spares during this initial production stage proved to be problematic. Then in January 1975 the U.S. Army selected the Roland II over the competing systems, but as it soon realized, one with a yet to be stabilized design.

February 1976 saw the first test firings of the production 'Tranche 1a' missiles at the French MOD's Centre d' Essais en Landes (CEL) with nine successful firings out of 10.

A Common Procurement Program (PAC-Programme d' Approvisionenment Commun) was negotiated by the two governments between 1974 and 1976 to cover work distribution from Tranche 1a through Tranche 4 in the mid-80's. By this time

both nations were to have completed procurement for their own forces totaling 600 fire units and 20,000 missile—200 fire units for the French army, 200 for the Bundeswehr and 200 for the Luftwaffe. Monthly production rates were planned to cover the French and German orders plus estimated foreign sales.

Then in 1980 and 1981 the sky fell in. The Luftwaffe indefinitely postponed its purchase decision which threatened to shut down the German production lines. Contingency plans were made to move production to France. Shortly thereafter the U.S. production line, which had received the green light for low rate production in 1979, fell by the wayside as a new administration entered office. The DoD finally allowed the U.S. Army to unload its foreign born system. Fortunately Euromissile was able to rebound from this double set back through landing a series of foreign sales in the Middle East, and nearer home, in 1984, a Spanish Army order. By then the U.S. had done another about face, having agreed to a swap with the FRG in which the Germans provided Roland II's for the defense of U.S. Air Force Europe air bases in return for Patriot SAM's for high altitude coverage.

When Euromissile was set up in 1972 to manage the Roland and the two anti-tank programs, form had finally come to reflect what was in fact already the reality of a partnership among co-equals. In spite of SNIAS having been the prime contractor and MBB the principal subcontractor (similar to the Dassault-Breguet and Dornier relationship for the Alphajet), the team had been operating within the frame work of a heavily watered down contractual hiearchy. As emphasized by the Euromissile representative to Boeing from

1979-1982, Bruno Didelot, the key to the successful working relationship lay more with mutual trust, than with any given organizational formula.

Another aspect of this diluted sense of heirarchy was the fact that Euromissile—SNIAS/MBB did not select its major subcontractors, it only negotiated, approved, and administered the specifics of the contractual arrangements. The two governments lined up those firms in the two nations with the proper specialties, sorting them out and ultimately designating the major members of the industrial team.

For final assembly and test, each country has it own fire unit production line. The missile, however, involves only one final assembly and test line at the SNIAS Bourges plant. Originally the French fire unit line was dedicated to the clear weather Roland I (optical sight only) version and the German line to the Roland II with the track radar. Now however, with the French Army also procuring Roland II's, this version comes off both lines. SNIAS and MBB each have a different approach to fire unit assembly. SNIAS receives its AMX-30 tank chassis from the GIAT facility at Roanne and intergrates the assembled fire unit into the vehicle itself at Bourges. MBB on the other hand, sends the major fire unit subassemblies on to Thyssen for integration into the Marder Spz vehicle. (Note that these two national standard vehicles are outside of the Euromissile production sharing arrangement. Here each country opted for intra-service over inter-allied commonality).

The basic rule for all three tactical missile programs at Euromissile is that they be 50:50. This means that within Euromissile and at the SNIAS-MBB level,

the goal of a approximately 50:50 program holds—be it for financial or design and development responsibilities. At lower levels for the subsystem contractors there has been greater flexibility with implementing the 50:50 work sharing goal - which here is not an absolute requirement. Shifts, planned and actual, for work balancing purposes have created a more fluid situation for the subcontractors. It is understood that the original PAC could be eroded over time.

First of all, the task of tallying up the value of the respective work shares is not as simple as it might seem. One common accounting unit, be it arbitrary, and a certain fluctuation range are necessary in defining a base against which the balance or the need for readjustment can be calibrated. For example, pressure began to build up in the FRG in the late 70's for a readjustment in their favor because of the extreme shifts in the relative value of the two national currencies.

Implementing a 50:50 goal at lower tiers has naturally been difficult to manage - numerous compromises were necessary. In addition to the developmental to production facility shift in the 1975 and 1976 time frame the need to transfer work across the Rhine in both directions (though there was a greater volume in the France to FRG lane) further hurt the learning curve. As is readily apparent from the following examples, the break down of work below MBB and SNIAS does not follow clear cut national lines either.

MBB			SNIAS	
Thomson-CSF	- Track radar		SAGEM	- electro-optical sight
Siemens	- surveillance radar		Eltro	- gonio
AEG-Telefunken	- Command transmitter and missile antenna		SAMM	- hydraulics
			SAT	- optical part of gonio
Thyssen-Mors (FRG subsidary)	- vehicle		ATS	- cupola
			GIAT	- vehicle
	- slip rings		SNPE	- booster and sustainer grains pyrotechnical devices and flares
Souriau (FRG subsidary)				
	- connectors			

In accordance with the usual contracting hierarchy, firms of the two nations work to the specifications/standards of their respective prime contractor regardless of which side of the Rhine they are on. French and German firms have no significant problems working to each others process, material and part specs since they are now quite similar, and having become more so over time as the relationships on joint programs dating back to the late '50s have matured.

The most significant case of trans-Rhine prime-subcontractor teaming involved the design and development of the track radar for the Roland II. Due to the FRG having taken the lead in the development of an all-weather capability, MBB logically assumed primary responsibility for this variant. The only contractor deemed capable in either country at the time however, of designing a track radar for the Roland was Thomson-CSF. Thomson-CSF had been the only one of the five European National Prime Contractors (NPC's) to fully digest the know-how from the U.S. firm Raytheon acquired during the NATO Hawk project (a medium altitude all-weather SAM system). AEG-Telefunken, the German NPC had not been nearly as successful in this regards. Thomson-CSF, however, was also developing its own SAM system for the French Air Force for base defense - the Crotale, a competitor of the Roland (a French Army/Bundeswehr/Luftwaffe

system). The Thomson-CSF program manager for Roland Track radar development was credited by Jacques Sorlet of Euromissile with, in the end, having made a major contribution to the program. He played his conflicting role very adeptly, successfully defending his Roland effort internally.

After transfer of the Roland II technical data package (TDP) to the U.S. for license produciton began, the U.S. switched over to a Hughes track radar for production.

Later once the design of the Thomson-CSF track radar had stabilized much of the work was broken out and transferred across the Rhine to Siemens. Several other examples of work transfer included:

connectors	-Souriau (Fr) to Souriau Gmbh (Dusseldorf)
launch tubes	-SNIAS to MBB
booster grains	-SNPE to Bayer Chemie

In the latter two cases dual sources were maintained. Manufacturing license agreements to cover the usual proprietray rights, royalties and so forth were also negotiated unless this trans-Rhine transfer took place within one firm as with Souriau.

Work balancing also involves resorting to the breakout of work through subcontracting. For example SNIAS as part of its missile responsibilities subcontracted the warhead to the specialized plant within another division of MBB at Schrobenhausen about (100 km north of Munich). MBB-Schrobenhausen in turn spun off by subcontract elements of the warhead to Luchaire back in France.

To further complicate an already complex network of trans-national contracting, planning was underway in 1980 and 1981 to transfer production back into France after the Luftwaffe balked on its 200 fire unit order.

H. ASSM

A project closely related to Euromissile is the second generation anti-surface ship missile (ASSM) project, originally designated NATO ASSM-II. ASSM is worth treating in some detail here because it is a highly representative project in two ways. One, it is an excellent example of the post 1966 NATO procedures for cooperation in research, development and production, contained in NATO Unclassified Document, C-M(66)33. It illustrates the interrelationships of the NATO Industrial Advisory Group (NIAG), the Council of National Armaments Directors' (CNAD), and its subordinate main Armaments Groups (the NATO Naval Armaments Group (NNAG) in this case) and industry in general. Two, it is also highly representative in that it portrays the gradually intensifying European collaboration on one hand, and the more restrained forms collaboration is assuming on the transatlantic level.

1. NIAG Sub-Group 8, the Pre-feasibility Study

In November 1974, the NATO Naval Armaments Group (NNAG) agreed on the outline NATO staff operational objective (OOO)[216] for a second generation anti-surface ship missile (ASSM-II) which had been drafted by one of the NNAG's six permanent Information Exchange Groups (the one concerned with above surface warfare), and invited the NATO Industrial Advisory Group (NIAG) to conduct a pre-feasibility study[217] for ASSM-II.[218]

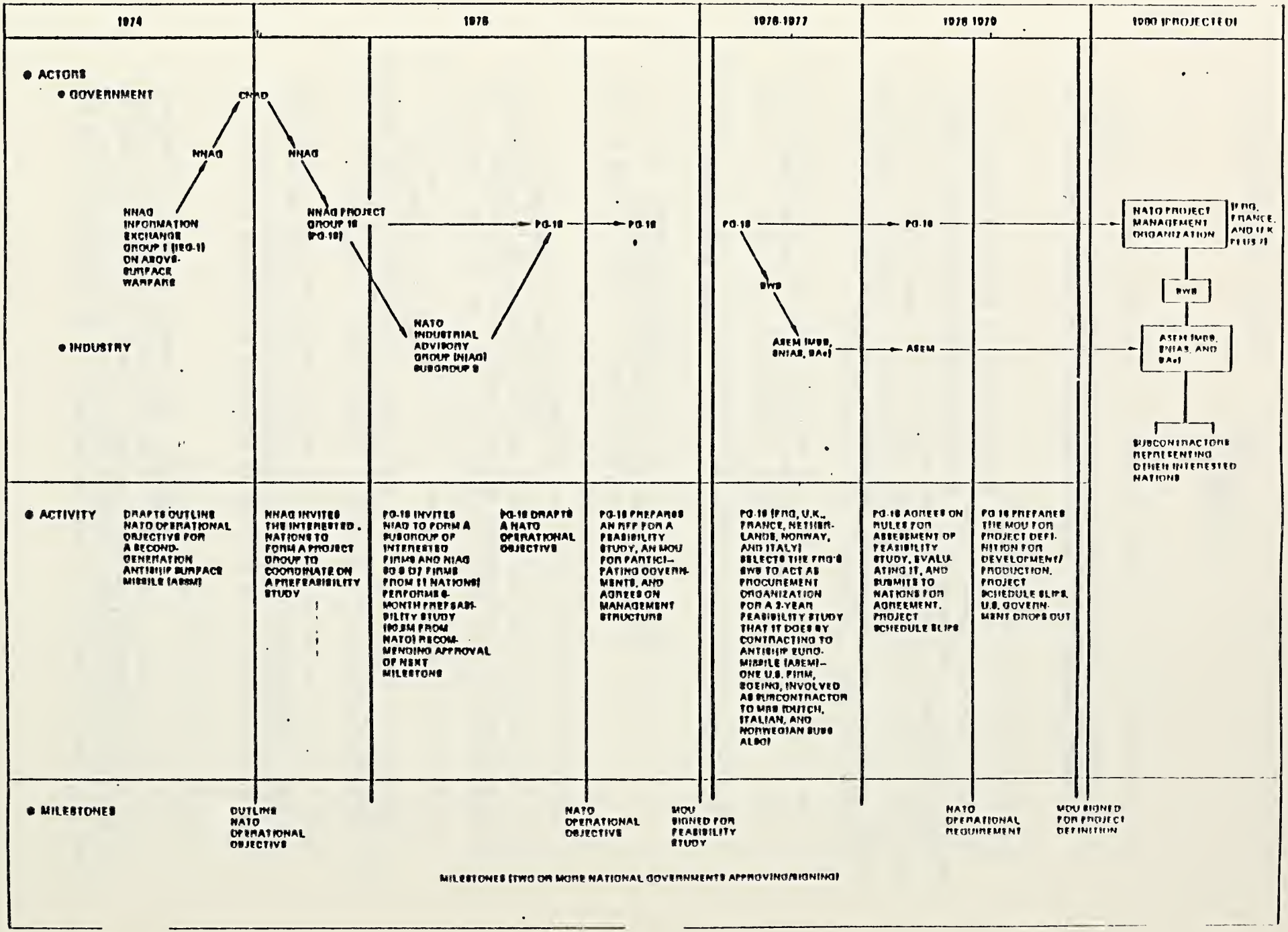
Additionally, the ASSM-II project was submitted to the Defense Planning Committee (DPC), i.e., the NATO Defense Ministers, as one requiring special

attention, and described it as a project which could become an outstanding example of effective NATO armaments collaboration and standardization. The Defense Ministers agreed to concentrate their efforts, both individually and collectively on ASSM-II. NIAG proceeded to organize NIAG Sub-Group 8 to begin the pre-feasibility study.[219] All interested firms from the 15 member nations were invited to participate. The study's objective was to identify and evaluate alternative approaches to satisfying the outline operational objective.[220]

NIAG Sub-Group 8 initiated the pre-feasibility study in January, 1975 with 37 companies and 11 NATO nations participating (all NATO members (including France)) except for Denmark, Greece, Iceland and Luxembourg. This pre-feasibility study was the first one to be partially funded out of NATO's civil budget, to the tune of 1/2 million dollars. Work was broken down into five technical areas, each the subject of a separate team under the leadership of one firm. A sixth team was set up for overall system coordination.

	TEAM	LEADER
(1)	Total System Coordination	BAC--UK
(2)	Airborne and Propulsion	MBB--FRG
(3)	Guidance and Autopilot	MSDS--UK
(4)	Warhead & Fuze	MBB--FRG
(5)	Installation and Integration	TH-CSF--France
(6)	Report Coordination	HSD--UK

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1974
1975
1976-1977
1978-1979
1980 (PROJECTED)
● ACTORS
● GOVERNMENT
CNAD
NNAG
NNAG
NNAG INFORMATION EXCHANGE GROUP 1 (IEG-1) ON ABOVE-SURFACE WARFARE
NNAG PROJECT GROUP 16 (PG-16)
PG-16
PG-16
PG-16
PG-16
PG-16
BWB
NATO PROJECT MANAGEMENT ORGANIZATION
(FRG, FRANCE, AND U.K. PETIS ?)
BWB
● INDUSTRY
NATO INDUSTRIAL ADVISORY GROUP (NIAG) SUBGROUP 9
ASEM (MBB, SNIAS, BAe)
ASEM
ASEM (MBB, SNIAS, AND BAe)
SUBCONTRACTORS REPRESENTING OTHER INTERESTED NATIONS
● ACTIVITY
DRAFTS OUTLINE NATO OPERATIONAL OBJECTIVE FOR A SECOND-GENERATION ANTISHIP SURFACE MISSILE (ASSM)
NNAG INVITES THE INTERESTED NATIONS TO FORM A PROJECT GROUP TO COORDINATE ON A PREFEASIBILITY STUDY
PG-16 INVITES NIAG TO FORM A SUBGROUP OF INTERESTED FIRMS AND NIAG SG 9 (7 FIRMS FROM 11 NATIONS) PERFORMS 6-MONTH PREFEASIBILITY STUDY (SG 9 FROM NATO) RECOMMENDING APPROVAL OF NEXT MILESTONE
PG-16 DRAFTS A NATO OPERATIONAL OBJECTIVE
PG-16 PREPARES AN RFP FOR A FEASIBILITY STUDY, AN MOU FOR PARTICIPATING GOVERNMENTS, AND AGREES ON MANAGEMENT STRUCTURE
PG-16 (FRG, U.K., FRANCE, NETHERLANDS, NORWAY, AND ITALY) SELECTS THE FRG'S BWB TO ACT AS PROCUREMENT ORGANIZATION FOR A 2-YEAR FEASIBILITY STUDY THAT IT DOES BY CONTRACTING TO ANTISHIP EURO-MISSILE (ASEM)—ONE U.S. FIRM, BOEING, INVOLVED AS SUBCONTRACTOR TO MBB (DUTCH, ITALIAN, AND NORWEGIAN SUBS ALSO)
PG-16 AGREES ON RULES FOR ASSESSMENT OF FEASIBILITY STUDY, EVALUATING IT, AND SUBMITS TO NATIONS FOR AGREEMENT. PROJECT SCHEDULE SLIPS
PG-16 PREPARES THE MOU FOR PROJECT DEFINITION FOR DEVELOPMENT/PRODUCTION. PROJECT SCHEDULE SLIPS. U.S. GOVERNMENT DROPS OUT
● MILESTONES
OUTLINE NATO OPERATIONAL OBJECTIVE
NATO OPERATIONAL OBJECTIVE
MOU SIGNED FOR FEASIBILITY STUDY
NATO OPERATIONAL REQUIREMENT
MOU SIGNED FOR PROJECT DEFINITION
MILESTONES (TWO OR MORE NATIONAL GOVERNMENTS APPROVING/SIGNING)

The U.S. was represented by Teledyne Belgium S.A. on Team 3, Texas Instruments on Team 3, Marquardt on Team 2, McDonnell Douglas Astronautics, Team 1, and Lockheed Missiles and Space, Team unknown.[221]

In June, 1975 Sub-Group 8 submitted to CNAD its pre-feasibility study demonstrating the feasibility of a solution to the outline operational objective:

(1) The outline operational objective could be met without any extreme state-of-the-art development.

(2) Ramjet rocket, radar seeker and ECM technologies are major considerations for 1985 service entry date.

(3) A modular missile is very feasible:
    (a) propulsion module
    (b) payload module

(4) The time scale is technically sensible.[212]

In addition, NIAG Sub-Group 8 recommended that either a single missile be considered for development, one suitable for all the launch vehicles, or a small family of missiles be developed, having a limited number of variants matched to individual classes of launch vehicle.

The launchers should be suitable for a variety of different classes of vehicle.

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As for fire control equipment, each launch vehicle could present target data in a different format. Each vehicle class or type might therefore present a different interface problem to the ASSM.

For support equipment, a variety of equipment would be needed to test, service, repair and handle the missile and its launch and fire control gear. A system was required which would have maximum common content to ensure inter-operability, but which at the same time would be compatible with the operating procedures and equipments of a number of user services. It was envisaged that the ASSM would include a common core of test, servicing and handling equipment, to which each user service would add the interface equipment necessary to match it to its own procedures and equipment.[213]

2. NIAG's Advise on Collaborative Arrangements

In May 1975 (the ASSM Outline Operational Objective report was to be issued by the NIAG sub-group in June, 1975) CNAD requested NIAG to comment on suitable collaborative arrangements between the nations of NATO for the development and production of ASSM. The author, L. G. Evans, Chairman of NIAG Sub-Group 8, assisted by a P. Lawrence, were therefore invited: "To study, in principle, the options open to NATO for the cost-effective development and production of the Anti-Surface Ship Missile, and to make recommendations as to how their procurement should be organized."[214]

At its December 1975 plenary meeting, the NIAG examined this report prepared at its request by Mr. L. G. Evans, Chairman of NIAG Sub-Group 8, on the

options open to NATO for the cost effective development and production of the anti-surface ship missile system. Mr. Evans, who was acting in a personal capacity, also made recommendations as to how procurement should be organized. Following is a summary of the report prepared for circulation to NIAG.

The authors considered management systems which were used for a number of prior international collaborative projects in which development played a major role, with a view to avoiding past failures, and following or building on past success. The study pointed out certain common features distinguishable in the successful management systems tried. These are:

(1) The system should ensure that individuals participating have a high level of motivation toward success of the project.

(2) The organizers should recognize the differing goals of the participants, both in government and in industry, and be able to arrange the tasks so as to enable these goals to be met.

(3) It should be recognized that the goals of the participants will change as time progresses and the organization must be able to cope with these changes.

(4) The management system should enable those concerned to carry out their tasks without continued government interference by setting up strong leadership and avoiding the need to refer decisions back.

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(5) The management teams should be recruited from individuals having international, as opposed to national, aspirations for the project as a whole.[215]

The authors then reviewed five possible management systems, identified as worthy of consideration. Each had been tried on at least one project and an attempt was made to draw conclusions from such experience.

(1) Appointment of a single nation to develop the system - citing such previous projects as Polaris (successful), and Skybolt and F-111 (both unsuccessful). Although this system is the one currently advocated by the U.S., having the merit that it allows all nations to profit from skills already developed by other nations in the Alliance, and it would lead to improvement in the cost effectiveness of weapon development programs in NATO, NIAG as a whole felt that it could not recommend this method of collaboration for ASSM. Its reasons were as follows:

(a) The solution adopted for ASSM must stand on its own, without any trading off of work on other projects.

(b) There are serious mutual confidence problems since the nation undertaking development must have confidence that the passive nations will purchase the system in suitable quantities and will not start competitive projects, while the passive nations must trust in the projects being brought to fruition and that their requirements will be met as well as being made available freely.[216]

(c) The passive nations and their industries must accept that their development skills are not exercised on the project, surrendering either temporarily or permanently certain branches of technology which in turn involve considerations of national technology.[217]

(2) Collaboration in development using existing national procurement systems - citing the case of the Anglo-French Martel AS missile project. This method of collaboration, involved a sharing out of the work between participating nations, each conducting the work through its own existing national procurement system. In the case of the Martel each national government took charge of one of the versions of the missile, procuring through its own existing Government procurement system its allocated part of the work, with each Government undertaking to accept the work conducted by the other. Concluding that this primative management system led to successful development of the Martel "in spite of," rather than "because of," the management procedure adopted by the two nations. The authors pointed out that if the system operated only with difficulty between two nations it would be much more so if more nations were involved. As such, the Martel project makes the importance of having a single centralized procurement system for the ASSM project clear.[218]

(3) Purchase by a single government. The authors cited the example of NATO Sea Sparrow, but for our purposes the following also apply for the Alpha Jet. The simplest system in which one centralized procurement procedure is utilized to arrange for all the work to be purchased by the Government procurement agency of one of the participating nations on behalf of all

the others. Although a number of the probable participants in the project have advanced procurement systems that could be made available to serve as the lead system for ASSM, and that the system has the merit of speed, for it avoids the delay of instituting a new procurement system it could not be recommended for the ASSM project. The reasoning for this involved the following considerations:

(a) One would suspect that the adoption of such an arrangement would tend to favor the "lead nation" who would be more competitive on their home ground.

(b) Although it is much easier to select the lead nation when, as in the case of NATO Sea Sparrow, the project is a development project based on a prior project already developed within the procurement system of the largest national participant, this would not be the case for ASSM. In starting a new project, in which several of the major NATO nations are expected to participate, the choice would not be nearly so obvious, resulting in a delay in agreement as well as bias in the final result.

Therefore, the authors believed that NIAG should not recommend this management system. Instead, the procurement system chosen should be one in which all governments play a part and one which doesn't favor the industry of any nation. As such the authors felt that an internationally based procurement system should be set up for the ASSM system.[219]

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(4) When more than two governments become involved the situation can become exceedingly complex and usually a joint international management agency is introduced to represent the governments and manage procurement. Since all prior collaborative missile development projects had been on a bilateral basis, examples of international agencies were drawn from other developments.

(a) The latest aircraft development is the NAMMO/NAMMA organization used to manage and procure the MRCA on behalf of the United Kingdom, Italy, and the FRG. As treated earlier in this chapter, this consists of a policy organization (NAMMO) made up of three senior government officials and the Management Agency (NAMMA) with staff of about 200. A number of points were made regarding this organization. One is that it relates to an aircraft project and is therefore larger than any similar arrangement would be for procuring a missile. Another is that it did not carry out feasibility studies; these were carried out nationally beforehand. Finally NAMMO and Panavia are regarded by the participants as the most advanced government and industrial arrangements for NATO international procurement where a NATO organization has been entrusted with national funds for the procurement of a very complicated weapon system.[220]

(b) Most national procurement agencies have, or have access to specialized facilities to assist them in making technical decisions.

NAMMO does not have such facilities but depends upon those of the participating governments.

ESRO as the international procurement arm of the European Space Agency has developed such support facilities, mainly at ESTEC. This agency has been responsible for a number of projects, and has fully procured and managed several space projects by cost-incentive contracts to industry. For each of its projects, the work is spread among the participating nations in accordance with the constraints required by national governments and the funding arrangements. Industrial consortia respond to ESRO requirements and it is their responsibility to achieve harmonious inter-company relationships while satisfying the defined constraints and requirements. However, it was very unlikely that governments would be prepared to go to the length of setting up such an agency for one missile project.[221]

Evans and Lawrence therefore concluded that an organization similar to the NAMMO/NAMMA arrangement could be used as the basis for the system to procure the Anti-Surface Ship Missile (ASSM) System.

Based on the Evans and Lawrence report, NIAG recommended that a single international procurement system similar to that of NAMMO for the MRCA be set up by the governments participating in the Anti-Surface Ship Missile System. It was suggested that it be set up to procure the ASSM in the first instance, but with the prospect of expansion to cover other projects, should appropriate decisions be taken. They recommended that the system be based on the NAMMA

procurement system, being adjusted as necessary to match the participation in the Anti-Surface Ship Missile System, and to suit it for the specific procurement requirements of guided weapons. Although a major task, this could be accommodated in the required timescale.[222]

Whatever the pros and cons for any given project of the two general approaches represented by the MRCA Tornado and the Alpha Jet, for ASSM at least, the model adopted was that of the MRCA.[223]

The authors felt that the question of how industry should be organized should not be addressed. Their reasoning was that this was an area of prospective competition, about which it would be improper for NIAG to make proposals. Companies should be as free to offer competitive management arrangements, as to offer attractive technical solutions and prices. It must be left to individual companies to form their collaborative arrangements, and to decide whether to offer, for example, prime contractorship on the Panavia pattern, or a consortium, or whatever other arrangement appears appropriate.[224]

At the April 27-29, 1976 meeting of the CNAD, the NIAG Planning Committee Chairman, reported to CNAD that NIAG had achieved an excellent two-way traffic with the Main Armament Groups, and especially with NATO Naval Armament Group (NNAG). As an example he cited the ASEM pre-feasibility study which was completed within a record time of six months by NIAG Sub-Group 8.

Although NIAG Sub-Group 8 had been disbanded, the Chairman told CNAD that NIAG would continue to be available to give advice at the request of CNAD or NNAG

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PG/16. In reference to Sub-Group 8's study the Chairman further stated that, "the NATO navies appeared to have found the right formula in requesting industry to undertake pre-feasibility studies at the earliest possible stage when they themselves were engaged in elaborating their outline operational objectives."[225]

3. NNAG's Project Group 16

The NIAG recommendation to expand the outline operational objective into a full NATO operational objective[226] was approved, and in October 1975, the NNAG established Project Group 16 (PG-16) to carry the project forward.

PG-16 work has been carried out in two phases with the initial focus on a feasibility study[227] of the full NATO operational objective (OO).

PHASE I

Goal - Prepare terms of reference for a feasibility study and draft a memorandum of understanding for the feasibility study.

Participants - All interested nations (France, FRG, Italy, Netherlands, Norway, U.K., U.S.).

PHASE, II

Goal - Issue feasibility study RFP, draft operational requirements,[228] complete project definition, establish a NATO Project Steering Committee and NATO Project Office.

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Participants - Nations undertaking financial commitments (France, the FRG, Italy, the Netherlands, Norway, U.K., U.S.).

Phase II began with the signing of the MOU and the establishment of a provisional NATO Project Office. Industry participated in all of the Phase II steps with the extent of the participation being that agreed upon by the nations active in PG-16.[229]

Difficulties arose in March, 1976 over agreement on industrial property rights, cost and work sharing, and identification of national lead contractors. However, in September preliminary agreement was reached among the seven participating nations and the feasibility study MOU was signed in November—eight months behind schedule.[230]

ASEM involvement was being sought by the U.S. Navy primarily in support of DoD policy stating that cooperative research and development programs will be pursued where the potential for NATO standardization and interoperability exists. The ASEM operational objective emphasized many of the capabilities desired by the U.S. Navy; however, the Navy's position was to pursue an independent parallel program, and then look for commonality and interoperability. The U.S. Navy decided not to seek a visible role in the ASEM project at that time, but agreed to fund and contribute to the launch platform compatibility aspect of the feasibility study, and in return, would have complete access to the study results. However, the issue regarding ownership and the right to use that data remained unsettled.[231]

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The government management and procurement structure would evolve as the project progresses through its two primary phases, pre-development and development. During the project definition phase, the NNAG's PG-16 administered the feasibility study, assuming the role of the provisional NATO Project Office. Prior to commencement of the full scale development phase rescheduled for 1980, PG-16 will most likely be dissolved and a more formal NATO management group established to oversee development and procurement.[232]

PG-16 was assigned two separate management roles during the pre-development phase of the project. First, the entire PG-16 membership serves as a government board of directors; meeting quarterly and acting as a policy group. Second, a PG-16 subgroup acts as the day-to-day government operating management organization (SPO). This management subgroup is composed of France, the United Kingdom and the FRG, with the FRG's BWB (Bundesamt fuer Wehrtechnik und Beschaffung) located in Koblenz, acting as the government contracting agency for the DM 12 million feasibility study.[233]

As stated above, the U.S. participated only in the government board of directors aspect of the PG-16 management structure. Overall ASSM involvement continued to be the responsibility of the U.S. Navy Director for International R&D, while responsibility for direct participation in PG-16 activities remained with the U.S.N. Harpoon Project Office supported by John Hopkins-APL.[234]

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4. Anti-Ship Euromissile (ASEM)—the Industrial Consortium

ASEM was prime contractor to BWB for the feasibility study. Membership in the Anti-Ship Euromissile Groupement d'Interet Economique includes MBB, Aerospatiale and British Aerospace (BAe). These are the three designated contractors of the three principal nations involved in the project—the first time Europe's three medium powers have gotten together on one project. Euromissile offered itself on the industrial side as the suitable program management organization for the production of the NATO ASSM. The consequence of the transfer of this task to Euromissile, however, would have meant that the newly founded British Aerospace Corporation would have had to have been considered as an equal partner to Aerospatiale and MBB, which was out of the question for Euromissile, on account of their current competitive situtation in seveal areas (e.g. Rapier-Roland).[235]

For this reason a way out was found in the setting up of another Groupement d'Interet Economique (GIE), named ASEM (Anti-Surface Euromissile), created exclusively for the ASSM program and shared in three equal parts by Aerospatiale, MBB and Hawker Siddeley Dynamics (now part of British Aerospace). The ultimate aim when the teething problems with the new UK partner are solved, however, is to integrate ASEM into Euromissile.[236]

Although ASEM is by no means a subsidiary of Euromissile, there is a very close association between the two companies. This association is manifest in the fact that four of the six ASEM board positions are portfolios belonging to the same people serving on the 4-man Euromissile board. This is mainly

intended to ensure the continuity of Euromissile's philosophy, policy and management practices. The two other board positions at ASEM are filled by BAe officials. As of early 1977, the management of ASEM was made up of three equally empowered executives: Technical Manager and ASSM Program Director-MBB; Sales Manager-BAe; and Administrative Director-Aerospatiale.[237]

Though this is somewhat awkward and voluminous organization relative to the job in hand (feasibility study with a contract value of only DM 12 million running only 14 months) it was the only solution because of the setup of a new cooperative program with an as yet unknown partner.[238]

The new GIE is also based near Paris, where ASEM was accommodated in the Euromissile building until it took over its own offices.

The three "major" partners—the FRG, France and the UK, each put up about 30 percent of the necessary working capital. The remaining 10 percent was accounted for by Italy, the Netherlands, Norway and the USA; the latter's 1 percent share covering the responsibility of ensuring that the new missile can be fired from existing U.S. launch platforms.

Industrial contractors interface directly with PG-16 through the industrial management consortium, ASEM. The structure of ASEM had been determined to a large extent by the guidelines under which the feasibility study was conducted in line with three major constraints previously cited by the NIAG study:

(1) National expenditures are to be balanced by an equal amount of national work.

(2) Only one feasibility study is to be conducted.

(3) Participating governments nominated their preferred contractors. (Adhered to only by U.K., FRG, France, and Italy.)[239]

Work was shared out between collaborating nations by ASEM. The consortium is an autonomous body capable of making all management and financial decisions with little need to refer decisions back to national bodies. For those U.S., Dutch, Italian and Norwegian companies participating in the feasibility study, this meant a subcontract role in compliance with the balance of payments guideline.

U.S. companies were to seek participation with Anti-Ship Euromissile through normal commercial channels. Funding arrangements for U.S. contractor participation in the feasibility study were to be handled entirely by the U.S.N. Director of RDT&E. A fund flow mechanism was developed that guaranteed balance of payments equalization, yet allowed the foreign procurement and prime contracting organizations autonomous decision making authority over all management and contracting matters. The mechanism is basically a U.S. bank line of credit established by the U.S. Navy for U.S. contractors to draw against as work is performed on the feasibility study.[240]

The Boeing Aerospace Company, which had not participated in the NIAG pre-feasibility study, decided to pursue a protocol agreement with ASEM for the

U.S. production license. The company had marketing and licensing experience along this line with both MBB and Aerospatiale (i.e. Exocet and Kormoran anti-ship missiles and Roland SAM) and did not have a competing domestic program (McDonnell Douglas-Harpoon, General Dynamics-SLCM, Hughes-Condor). Additionally, Boeing was able to draw on PHM/Harpoon experience in performing the weapon system compatibility aspect of the feasibility study.[241] Consequently, ASEM selected Boeing to be the U.S. participant in the feasibility study.

In pursuit of its objective of obtaining the U.S. production license, Boeing entered the program as the industrial beneficiary of the U.S. government's 1% share. In 1977 Boeing received a $59,000 subcontract from ASEM with MBB acting as agent. For the ASEM feasibility study Boeing performed the launch platform compatibility study. The following year, in 1978, Boeing received an additional subcontract from ASEM/MBB for $11,000 for test program planning, which was primarily just an instrument for keeping U.S. industry in the picture, be it in a minimal way, during the interim phase preceding project definition.

Per the subcontract 'Purpose and Definitions' clause:

> BWB was 'the customer acting on behalf of NNAG Project Group 16'.
>
> The ASEM Groupement d'Interet Economique was the 'purchaser'.

The subcontract was as such subject to German law except, as defined by the catch-all caveat, "in so far as national regulations are applicable to the contract these will prevail over German regulations." The applicable regulations were the Allgemeine Bedingungen fuer Entwicklungs-vertrage mit industrie

firmen (A.B.E.I.) or the (German) "General Terms and Conditions for Development Contracts with Industrial Firms". The February 1971 edition of the A.B.E.I. Annex 6, applied subject to several minor wording changes and the numerous clauses and paragraphs cited as not applicable (N/A). The contract was structured as follows:

CLAUSE 1	PURPOSE AND DEFINITIONS
CLAUSE 2	SCHEDULE REQUIREMENTS
CLAUSE 3	TIME OF PERFORMANCE
CLAUSE 4	SUB-CONTRACTORS
CLAUSE 5	SECURITY
CLAUSE 6	PRICE & PAYMENT
CLAUSE 7	USER RIGHTS
CLAUSE 8	PLANNING AND REPORTING
CLAUSE 9	PUBLICATIONS
CLAUSE 10	EXTRAORDINARY TERMINATION, RESIDUAL REIMBURSEMENT
CLAUSE 11	OTHER TERMS OF THE CONTRACT
CLAUSE 12	PUBLICATION
CLAUSE 13	TERMINATION, SETTLEMENT OF RESIDUAL CLAIMS
CLAUSE 14	OTHER TERMS OF THE CONTRACT

As the ASSM represented an item on the Munitions List a draft of the sub-contract and SOW were submitted to the State Department's Office of Munitions Control (OMC), along with the DSP-5 application for a license covering the export of unclassified technical data that would ensue.

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5. The Nato ASSM Project Comes Undone

5. The NATO ASSM Project comes undone after completion of the feasibilty study, never reaching the project definition stage.

In late 1979, the U.S.N. terminated its association with the ASSM project, reportedly due to its being perceived as in competition with its Joint Medium Range Air to Surface Missile (JMRASM). This resulted in a considerable amount of ill feeling especially on the part of the Germans and French. As a result of the U.S.N.'s withdrawal, Boeing no longer pursued ASSM participation.

In any event, the following year after protracted problems in the area of system definition and lack of funding, the ASSM project broke up. France and the FRG were each locked into a design evolution based on their own systems, and the U.K. couldn't come up with the necessary funds.

6. ATEM

In December 1979, following the signing of an MOU by their respective governments, ASEM's three participating firms (MBB, Aerospatiale, and BAe) formed another Groupe d'Interet Econonique (GIE) in Paris. This GIE is the Euromissile Dynamics Group, and is to develop, produce, and sell a third-generation, medium and long-range anti-tank guided weapon system. Euromissile Dynamics and ASEM were to be merged as soon as is practical, and the three firms intended to pursue other weapon systems jointly in the future.

In 1980 ATEM picked up another project, as the three partner firms were designated by their respective governments to be the European licensee of the U.S. Army/Vought Multiple Launch Rocket System. (See Chapter 7)

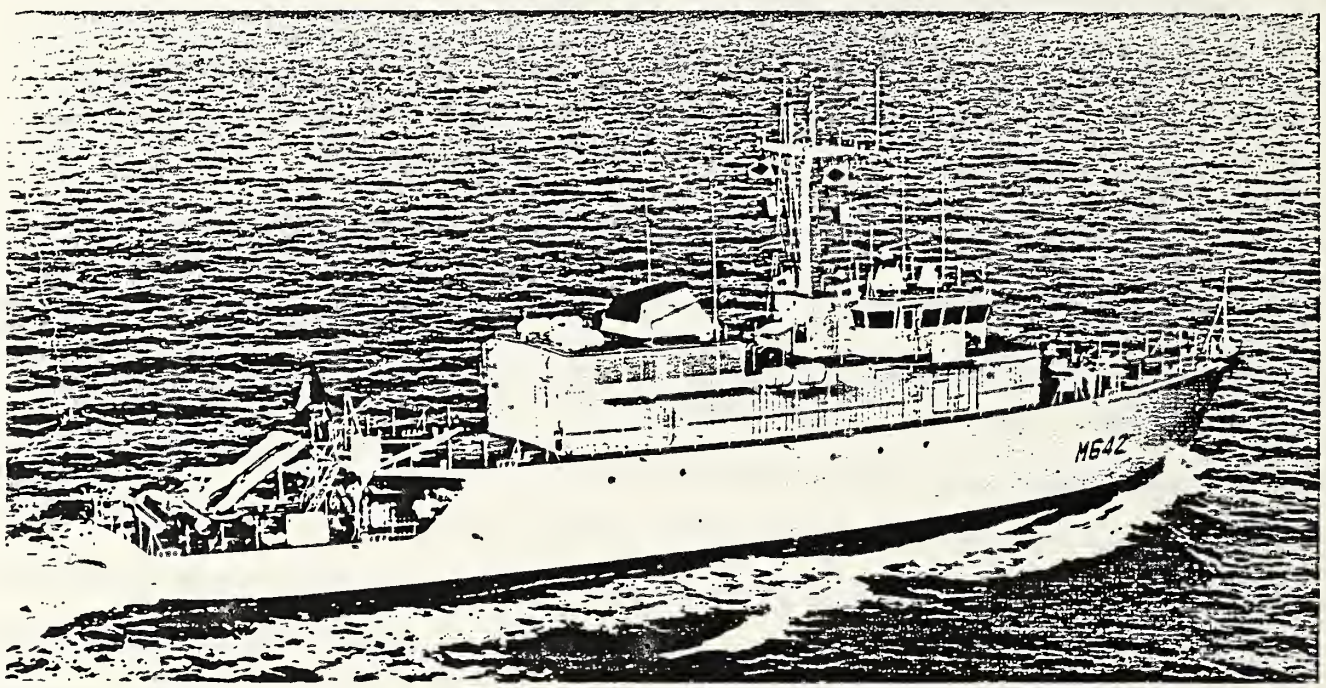
The Euromissile Dynamics Group (EMGD) is based in the same building as Euromissile in Fountenay aux Roses near Paris, sharing personnel with Euromissile, as did ASEM, in that the French and German managers of Euromissile where two hats in represently EMGD as well.

I. The Tri-partite Minehunter Program

In April 1974 the French, Dutch and Belgian navies agreed on the operational specifications of a new type of mine hunting vessel. Somewhat over a year later in May 1975, the three nations Defense Ministers signed an agreement covering the joint development, construction and logistic support of the minehunter. This project represented the first major cooperative ship design, development and production program for all 3 navies. This tripartite mine hunter involves the building of 40 vessels in shipyards in the 3 countries: fifteen for France to be built at Lorient, 15 for the Netherlands to be built at Van der Giessen de Noord; and 10 for Belgium to be built by a consortium called Polyship.[242] The 40 ships will all be identical to the Eridan prototype which was launched and began trials in 1979, and should all be in service by 1986.[243]

Although a number of existing sweepers were converted to minehunters in the late 1960s and early 1970s, the majority were by then too old for a major refit. Because of age and the need for modern hunters, most navies were planning new construction in this field.[244] It was obvious that the sophisticated equipment required would make these ships expensive. It was a logical step, therefore, for the leading Western navies to approach each other with a view to pooling their resources, to benefit from the advantages of a longer production run and other standardization related economics.[245]

As one might expect, however, it soon became clear that NATO-wide standardization would not be a practicable proposition due to the usual assortment of

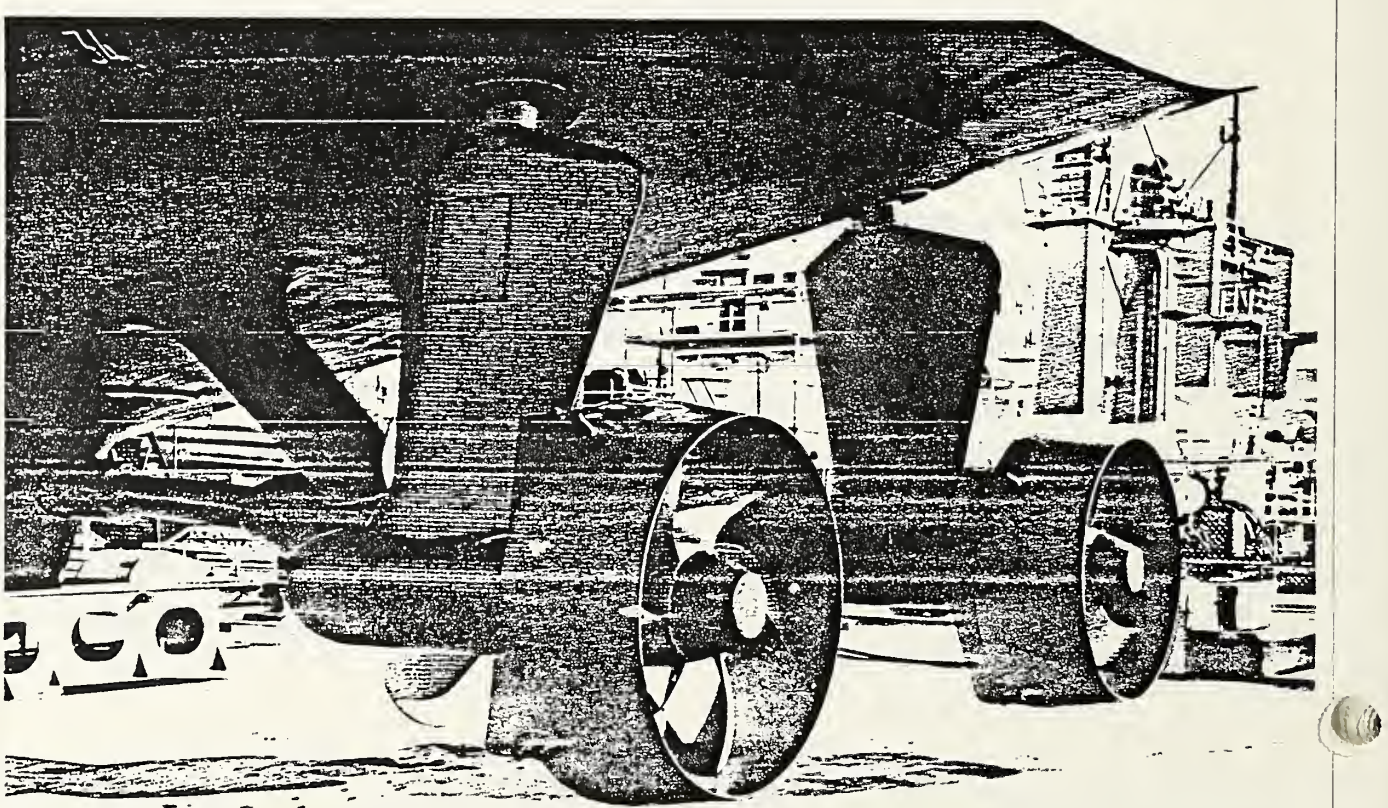


Modern minehunters must meet severe requirements:

- Manoeuvrability
- Aptitude for slow-speed movement
- Minimal acoustic and magnetic signatures
- Shock resistance

Through its experience in shipbuilding and in electro-mechanical engineering, ACEC was selected by France, the Netherlands and Belgium to design and build the electrical propulsion for the 40 minehunters of the TRIPARTITE class.

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activities in the three countries for the program, while the DTCN has responsibility for the technical and industrial aspects of the program. The DTCN is the French national naval construction agency and is responsible for the production of all basic plans and shop drawings. In addition, each country has appointed a representative to manage contracts and subcontracts placed with yards and equipment suppliers in his own country.[248] This corresponds closely to the governmental project management organization of the NATO Seasparrow project treated in greater detail in Chapter 10.

Orders for the equipment would be shared equally by the three countries, as would the R&D costs of the project. As regards equipment, it was decided that France would deliver the complete MCM system, the Netherlands the mechanical-engineering installation, and Belgium the electrical equipment, including the electrical auxiliary propulsion system. In this way, industries in the three countries will receive, financially, about equal shares of the total equipment pie. These equipment orders involve about 70% of the overall cost of the ship. The other 30% is constructional material supplied by the shipyard, such as hull materials, piping, cables, etc.[249]

Major systems selected, developed, and produced (all on a sole source basis) for the minehunter include:

- The DUBM-21A towed sonar by Thomson-CSF (France);
- The EVEC20 computer and display assembly developed by SINTRA (France);
- The Decca RM1229 navigation radar (UK);

- The PAP 104 to identify and neutralize both ground and moored mines by ECA (France);
- The main propulsion system, a 1,370 kW supercharged Werkspoor RUB 215 V12 diesel (the Netherlands);
- Development and production of the auxiliary propulsion system (the "active rudders") was assigned to ACEC (Belgium) which provides the immerged motors, the convertors and alternators itself, while obtaining from France's Turbomeca the ASTAZOO turbines and from the Netherlands, the bow propeller, produced by Schottel and Holec;
- The magnetometric de-gaussing device supplied by ENI (Belgium) and Thomson CSF (France).[250]

A number of key NATO Standardization Agreements (STANAGS) have also been adhered to for the system. The detailed study of the propulsion system, the selection of an entirely electric propulsion system controlled by the autopilot, complete suspension of the auxiliaries and the reduction of their vibration and sound energies have been carried out to meet the most severe NATO acoustic standards. In addition, the hull scantlings and the design and suspension of the auxiliaries protect the ship against the effects of nearby explosions, in accordance with NATO standards.[251]

The major pieces of equipment were tested on the measuring facilities of the Groupes d'Etudes Sous-Marines de L'Atlantique at Brest, to graph their magnetic signature and to determine local immunization circuits. A scale model of the complete ship was used to define the overall circuits at the Laboratoire de Magnetisme du Navire at Grenoble.

The Program Bureau also worked out the degree to which a common approach to logistical support would be followed. The three partners decided against a centralized, tripartite maintenance organization. Maintenance and stock management was to remain a national responsibility. Technical manuals and spare-part lists were to be identical, however. There was also to be a single fault-analysis and modification-management body, while certain spares, the repair of important items of equipment and software maintenance would be provided on a centralized basis.

In the training field too, a common training facility was expected to be installed at the Mine Warfare School of the Belgian Navy (run presently by the Belgian and Dutch navies) in Ostend. A minehunting simulator is expected to be installed there for the crews of the three countries.[252]

A sub-committee for External Relations has been set up for all discussions regarding the enlargement of the number of participating navies and any exports that might materialize. Discussions have occurred with German authorities, in particular.[253]

[1]The characteristics of the Chieftain were much criticized at the time, but it is noteworthy that most later tank designs have followed both these leads. The weak spot of Chieftain has always been its engine, it being well over half-way through the Chieftain's active life before its engine matched its other strengths. (D. M. O. Miller, "Main Battle Tanks—NATO and the Warsaw Pact," Military Technology and Economics, Issue 10, July/August, 1979, p. 10).

[2]This British gun, the 105 mm L7, was also adopted for the U.S.Army's M-60 tanks. Some 1,200 of the older M-48's were also converted to M48 A5's which included fitting a 105 mm L7, new tracks, 7.62 mm machine guns and other improvements. The M-60 itself was essentially an upgunned M-48A3. The M-48 was a system that had been rushed through the design stage under the pressures of the Korean war and the Stalinist threat to Europe, and first saw operational service in 1952. With the Chieftain, the British left their own 105 L7 gun behind and moved up to a 120 mm gun introduced at a time when the rest of NATO was more than satisfied with its 105-mm L7 gun). (Miller, op. cit.).

[3]The MBT-70 and PHM project histories treated in Chapter 10, and the AFVG fighter, treated in Chapter 13, bear out the danger that such backup alternatives can represent for joint development projects.

[4]Milton S. Hochmuth, Organizing the Transnational; The Experience with Transnational Enterprise in Advanced Technology, A. W. Sijthoff, Leiden, the Netherlands, 1974, p. 104.

[5]The acronym AMX stands for Atelier d'Issy les Moulineaux, the French governments armored vehicle arsenal near Paris, now named Groupement Industriel des Armaments Terrestres (GIAT).

[6]E. Vandevanter, Jr., Brigadier General, USAF (Ret.), Coordinated Weapons Production in NATO: A Study of Alliance Processes, The Rand Corporation, 1964, p. 57.

[7]Vandevanter, op. cit., pp. 57-8.

[8]Vandevanter cited the words of one reporter writing in the London Times, in 1963, in making the point that few knowledgeable people actually thought at the time that the issue actually hinged on which country had the better tank. "Belgian military circles say the French tank is superior to the German one, but other arguments will have to be taken into account, particularly the possible participation of the Belgian industry in the construction of tanks. The same argument made the Belgian Government choose three years ago the American jet Starfighter rather than the French Mirage."

[9]Divergences in the timetable, however, caused the cancellation of this joint project, with one nation wanting a tank for service in 1980, and the other wanting one for ten years later. The cancellation of the joint program led to the current British MBT-80 effort. (DMS Market Intelligence Report, "MBT-80," 1979).

[10]Though the Germans had in the interim unilaterally developed a radically improved version of the Leopard I, i.e. the Leopard II. This later tank incorporates multi-layer armor, and a 120 mm smooth-bore gun developed by Rheinmetall, improvements reminiscent of the British Chieftain . Offsets (Mode #6) for the purchase of the Leopard II are treatd in Chapter 11. At one

time the French, as well, planned to develop a new tank—AMX-32—with a 120-mm gun, but this project was dropped and 320 product-improved AMX-30s are to be purchased over the first half of the 80's, instead. (Miller, op. cit.).

[11]The Delegation Generale a l'Armament is France's Defense Procurement Agency.

[12]"Belgium Could Join Franco-German Tank Project," DMS Intelligence: International Defense, Volume 2, Number 9, March 3, 1980.

[13]"Netherlands interest in Franco-German Tank," DMS Intelligence: International Defense, Volume 2, Number 11, March 17, 1980.

[14] Jacques Isnard, "La France et l 'Allemagne federale devront cooperer a egalite pour la construction de leur char de combat des annees 90," Selection hebdomadaire du journal Le Monde du 20 au 26 November, 1980.

[15]Ibid.

[16]Ibid.

[17]Ibid.

[18]Ibid.

[19]Jean Wetz, "Bonn compromet par ses reductions budgetaires la cooperation militaire avec Paris et Londres, Selection hebdomadaire du journal Le Monde du 5 au 11 mars 1981, p.4.

[20]Jacques Isnard, "Une defaillance lourde de consequences," selection hebdomadaire du journal Le Monde du 5 aull mars 1981, p.4.

[21]Isnard, "La France . . . " op. cit.

[22]Isnard, "Une defaillance . . . " op. cit.

[23]Isnard, "La France . . . " op. cit.

[24]Wetz, op. cit.

[25]Ibid.

[26]Ibid.

[27]Isnard, "Une defaillance . . . " op. cit.

[28]Ibid.

[29]Roger Facer, The Alliance and Europe: Part III, Weapons Procurement in Europe--Capabilities and Choices, International Institute for Strategic Studies, London, 1975, Adelphi Paper No. 108, p. 47.

[30]German for "consortium"

[31]Aviation Week & Space Technology, June 2, 1969.

[32]A. H. C. Greenwood, "MRCA—The Future System of Military Procurement," RUSI Journal for Defense Studies, Vol. 117, July/September, 1972, p. 5.

[33]The plane was built for the order of the French and German Governments, with due consideration for a possible Italian requirements which never materialized, Italy thus being represented on the steering committee as an observer but not financially involved, or voting.

[34]Henri Ziegler, President of France's Sud-Aviation quoted in the September 16, 1968 issue of Aviation Week & Space Technology, singled out a number of other lessons that had been learned from his experiences in the Transall and a number of other collaboration aircraft projects collectively.

"The first and essential prerequisite, is that before any technical or

industrial joint venture gets under way, the specifications of the equipment to be developed and produced should be clearly and fully determined. It is better in the early stages to lose the amount of time needed to reconcile the users' points of view than to make a premature start on the basis of incompletely defined concepts which can lead to the need for the re-thinking (sometimes fundamentally) of studies already in progress."

"A second vital requirement is the establishment of legal, administrative and financial bases for the operation. The legal rules should specify rights and duties of each partner. By using empiricism rather than well-defined rules, clashes of authority, loss of time and inadequate control of expenditures result".

[35]Aviation Week & Space Technology, June 2, 1969, pp. 113-114.

[36]"New Transall Production Run Under Way," Aviation Week & Space Technology, November 14, 1977, p. 41.

[37]Facer, op. cit., p. 48.

[38]"Anglo-French Cooperative Ventures," NATO's Fifteen Nations, October/November, 1976, p. 79.

[39]"Anglo-French Cooperative Ventures," op. cit., p. 82.

[40]See Chapter 11 for a brief description of the Exocet offset.

[41]"Anglo-French Cooperative Ventures," op. cit. p. 82.

[42]L. G. Evans, and P. Lawrence, a report prepared for the NATO Industrial Advisory Group (NIAG) entitled "The Collaborative Development and Production of the Anti-Surface Ship Missile (ASSM) System", Document, NIAG (75) D/12 (Revised), August 12, 1976, p. 7.

[43]Ibid., p. 8.

[44]Ibid., p. 8.

[45]Ingo Niemzig, "the SP-70-1," NATO's Fifteen Nations, Oct. - Nov. 1981, p. 82.

[46]R. B. Pengelley, "FH-70—Europe's First Multi-National Artillery Program," International Defense Review, 2/1973, p. 195.

[47]Ibid.

[48]Ibid.

[49]Niemzig, op. cit., p. 84.

[50]Ibid.

[51]Ibid., p. 196.

[52]Ibid.

[53]The first models of the M-109 were delivered to the U.S. Army in the early 1950's.

[54]Niemzig, op. cit., p. 86.

[55]Ibid.

[56]Ibid., pp. 86-87.

[57]Ibid., p 87.

[58]Ibid.

[59]Ibid.

[60]Ibid, p. 88.

[61]The Leopard I was produced under license in Italy (Mode #1 of Industrial Collaboration).

[62]Harold Brown, Rationalization/Standardization within NATO, Department of Defense, A Sixth Report to the U.S. Congress, January 1980, p. 66.

[63]Niemzig, op. cit., p. 84.

[64]Ibid.

[65]Ibid.

[66]Aerospace International, March/April, 1976, p. 7.

[67]"Correction", Aerospace Daily, June 9, 1978, p. 218.

[68]"Mid-point in the Tornado program," Interavia, 2/1979, p. 137.

[69]"Tornado vital for NATO's changing requirements," Interavia, 11/1977, p. 1111.

[70]The AVS fighter project is covered in Chapter 10.

[71]The F-104G project is covered in Chapter 7.

[72]The Fiat G-91 project is covered in Chapter 5.

[73]The four Europeans produced the F-104G under license in a joint program, while the CF-104 was built under a separate Canadian program.

[74]"The MRCA Deadlock" Flight International, October 31, 1968, p. 694.

[75]The AFVG project is covered in Chapter 13.

[76]"The MRCA Deadlock," op. cit.

[77]Edward H. Kolcum, "France Moves to Join Fighter Consortium," Aviation Week & Space Technology, September 23, 1968, p. 17.

[78]Joined in 1969 by Hamburger Flugzeugbau (owned by the Blohm family) to form MBB.

[79]Edward H. Kolcum, "Joint Fighter Deadlock Over Leadership," Aviation Week & Space Technology, October, 1968.

[80]"The MRCA Deadlock," op. cit.

[81]Ibid.

[82]As of early 1972 a member of the British avionics industry was heard protesting their having been used as balancing agents in getting work figures right while also having not received adequate protection in the MOU's, nor adequate compensation through royalties and licensing arrangements. (RUSI Journal for Defense Studies, Vol. 117, July/September, 1972, p. 11.

[83]"The MRCA Deadlock," op. cit.

[84]"European Multi-Role Fighter Advances to Definition Phase," Aviation Week & Space Technology, May 19, 1969, p. 25.

[85]Edward H. Kolcum, "Holland Rejects Current MRCA Design," Aviation Week & Space Technology, July 7, 1969, p. 23.

[86]Edward H. Kolcum, "Problems Loom for Multi-national Fighter," Aviation Week & Space Technology, May 5, 1969, p. 27.

[87]"New European Fighter Evaluation Set," Aviation Week & Space Technology January 26, 1970, p. 21.

[88]Ibid.

[89]Edward H. Kolcum," Dutch Push New Fighter Program," Aviation Week & Space Technology, August 11, 1969, p. 114.

[90]Edward H. Kolcum, "U.S. Gaining MRCA Avionics Opportunity," Aviation Week & Space Technology, September 29, 1969, p. 20.

[91]Ibid.

[92]Ibid.

[93]Aviation Week & Space Technology, May 19, 1969, p. 25.

[94]Edward H. Kolcum, "MRCA Engine Choice Keyed to U.K. Drive," Aviation Week & Space Technology, November 10, 1969, p. 22.

[95]Ibid., p. 23.

[96]Ibid.

[97]The IMO's General Manager had been a Dutchman, General Stockla.

[98]Kolcum "U.S. Gaining...", op. cit., p. 21.

[99]Interestingly enough, the November 29, 1979 issue of Aviation Week & Space Technology, p. 13, reported:

> Italian government has presented a bill to the senate to exempt all materials and parts for the Panavia multirole combat aircraft from both customs duty and value-added tax. Taxes run into millions of dollars for the trinational program. Similar legislation has been introduced in Great Britain and West Germany.

[100]Neville Brown, "European Security: 1972-80," Royal United Services Institute (RUSI) for Defense Studies, April, 1972, p. 149.

[101]The Alpha Jet development program was redirected so that the FRG's 200 Alpha Jets would fulfill part of the MRCA's task. This involved a successful German initiative to save the Alpha Jet project, which found itself caught in a cross-fire between the U.S. and France in early 1970, with regards to joint training of pilots. This is covered in the next sub-chapter. Another interrelated procurement that soon came into the picture was the FRG's buy of 175 F-4F Phantoms to pro-vide an urgently needed replacement for the F-104G Starfighter in the air superior-ity role, as the Tornado program's schedule continued to slip.

[102]Another U.S. firm involved is Grumman. The Tornado's variable geometry wing box is based on that of the F-14, Grumman having provided technical assistance to MBB on titanium technology and the wing box's design. Grumman was to later re-enter the picture in another capacity in early 1979 as Panavia's partner (i.e. potential licensee) for the USAF's Enhanced Tactical Fighter (ETF) program. The ETF was to be an attack aircraft for the mid-1980's based on current designs, that was viewed as providing one answer to the USAF's problem of relatively weak capabilities in the night and all weather attack fields. (Aerospace Daily, "ETF Competitors Identified," March 28, 1979, p. 138.)

[103]"MRCA Meeting Targets," Aerospace International, March/April 1976, p. 10.

[104]"MRCA Reevaluation" Aviation Week & Space Technology, February 25, 1974, p. 21.

[105]Donald C. Winston, "MRCA Delayed Again by Engine Failure," Aviation Week & Space Technology, February 4, 1974, p. 17.

[106]Ibid.

[107]Interavia 11/1977, p. 12.
[108] Interavia 5/1975, p. 477.
[109]"Germans Worried About Tornado Delivery Delay," Aviation Week and Space Technology, December 4, 1978, p. 20.
[110]Interavia, 2/1979 p. 137.
[111]Eugene Kuzicharow, "Tornado Simplified for New Market," Aviation Week and Space Technology, April 21, 1980, p. 62.
[112]Ibid.
[113]Ibid.
[114]Ibid.
[115]Ibid.
[116] "Tornado Sales Effort Tied to Coproduction," Aviation Week & Space Technology, September 25, 1978, p. 54, and "Panavia Offers Tornado Offsets" Aviation Week & Space Technology, January 23, 1978, p. 17.
[117]Kozicharow, op. cit. p. 61.
[118]"Tornado Air Defense Variant Rolls Out at Warton," Aerospace Daily, August 10, 1979, p. 218A.
[119]"British Mull Tornado Program Change," Aviation Week & Space Technology, August 6, 1979, p. 17.
[120]As previously mentioned, Avionics Systems Engineering GmbH was also set up as an associate contractor but was disbanded early in the program.
[121]A.H.C. Greenwood, "MRCA-The Future Systems of Military Procurement," RUSI Journal for DEfense Studies, Vol. 117, July/September 1972, p. 9.
[122]"Die MRCA-Auftraggeber haben den Uberblick," Wehr und Wirtschaft, Issue #9, 1972, p. 399.
[123]Ibid.
[124]Ibid.
[125]Ibid.
[126]Ibid. pp. 399-400.
[127]Ibid. p. 400.
[128]Ibid.
[129]Ibid.
[130]Ibid.
[131]Ibid., pp. 400-401.
[132]"Panavia Picked to Provide Tornado Product Suport," Aviation Week & Space Technology, September 4, 1978, p. 221.
[133] Ibid. p. 223.
[134]Panavia: "Ready and Willing to Take on New Tasks," Military Technology and Economics, No. 11, 1979, p. 120 (hereafter referred to as 'Fichtmueller').
[135]The work sharing formula is also that of the partitioning of shares in Panavia GmbH. These shares have been frozen ever since the complete Dutch withdrawal, and the German order reduction from 600 to 400 aircraft, both in early 1970.

[136]Fichtmueller, op.cit., p. 121.
[137]Aerospace International, March/April, 1976, pp 6-7.
[138]Fichtmueller, op. cit., p. 121.
[130]Ibid., p. 122.
[140]Ibid.
[141]"Panavia Picked", op. cit. p. 223.
[142]"Product support...," op. cit., p. 142.
[143]"Mid-point...," Interavia, 2/1979 p. 143.
[144]"Tornado production: Centralized component manufacture—decentralized final assembly," Interavia, 11/1977 p. 1135.
[145]"Mid-point...," op. cit., p. 142.
[146]Ibid.
[147]"Mid-point...," 2/1979, p. 143.
[148]Ibid.
[149]Ibid, p. 142.
[150]Ibid., p. 143.
[151]"Panavia Picked," op. cit., pp. 223-5.
[152]Ibid., p. 221.
[153]Ibid., p. 223.
[154]Ibid.
[155]"Product support" op. cit., p. 144.
[156]Ibid.
[157]Ibid.
[158]Ibid.
[159]Ibid.
[160]Ibid.
[161]Ibid.
[162]Ibid.
[163]Ibid.
[164]"RB. 199 is Europe's biggest engine program," Interavia, 2/19/79, p. 145.
[165]"Product Support...," op. cit., p. 145.
[166]Fichtmueller p. 122.
[167]Ibid.
[168]Ibid.
[169]Ibid.
[170]See Chapter 12
[171]See Chapter 11
[172]"Alpha Jet development phase beginning," Interavia, 8/1971, p. 957.
[173]As previously brought out in Chapter 3 on the NADGE project with regards to the European electronics industry, the organization of such nationally balanced competitions has become more difficult over time. Not only were

Dassault and Breguet merged in successive stages in 1967 and 1971, which left VFW out in the cold for this competition, but VFW itself was in the process of merger with MBB during 1980.

[174]"Consortium Trainer Proposals Due January 2," Aviation Week & Space Technology, December 22, 1969, p. 21.

[175]Lt. Col. G.H. Fraidel and Lt. Col. V. Kreussler, "Close air support with the Alpha Jet," International Defense Review, 1974, p. 61.

[176]"Dassault-Breguet/Dornier Alpha Jet," DMS Market Intelligence Report, April, 1977, p. 2.

[177]This basic and advanced training is conducted with Cessna T-37's and Northrop T-38's respectively and has continued, at least into the early 1980's.

[180]"Dassault-Breguet/Dornier Alpha Jet," op. cit.

[181]"The Franco-German Alpha Jet - a status report," International Defense Review, August, 1972, p. 372.

[182]DMS, op. cit.

[183]As of September 1980 the Armee de l'Air was reportedly also considering the possible adoption of the close-air support version of the Alpha Jet, as of yet only procured by the Luftwaffe.

[184]Ibid.

[185]Ibid.

[186]"Alpha Jet development phase beginning," op. cit., p. 957.

[187]Among Dassault-Breguet's 15 different plants in France, Saint-Cloud is the prototype factory. It includes an engineering office which is responsible for the design of all military aircraft.

[188]The importance of this point was a lesson learned of a previous joint Franco-German project involving different firms, the Transall cargo/transport plane. A single design leader should be designated.

[189]Ernst Hoegenhauer, "Alpha Jet in Production," Dornier Post 1/1977, p.38.

[190]These same two firms also established a much more successful GIE in 1972 for their three collaborative tactical missile programs, Hot, Milan, and Roland.

[191]"Consortium Trainer Proposals Due...," op. cit.

[192]Hoegenauer, op. cit.

[193]Michael Brown, "Alpha Jet series production starts for 1978 deliveries," Interavia 2/1976, p. 120.

[194]Ibid.

[195]DMS, op. cit.

[196]Aerospace International, "Dassault is well prepared for future cooperation," May/June, 1980, p. 40.

[197]Ibid, p. 46. (For more on Dassault-Breguet's collaborative orientations see the Belgian and Spanish offsets treated in Chapter 11.)

[198]"Consortium Trainer...," op. cit.

[199]Brown, op. cit., p. 121.

[200]Jacques Isnard, "L'Iraq negocie avec la France la fabrication sur place de cent cinquante avions de combat Alpha-Jet," Le Monde (selection hebdomadaire) du 18 au 24 septembre, 1980, p. 3.

[201]Ibid.

[202]UPV—Union pour la Vente des Produits MBB et SNIAS, set up in 1965.

[203]"Euromissile, ASEM, and ATEM—nuclei of a future European guided missile industry?", International Defense Review, March 1977, pp. 469.

[204]Boelkow ownership was distributed in thirds between Boelkow, France's Nord Aviation and Boeing.

[205]"Euromissile . . .," op. cit.

[206]The curious abberations this results in in practice are worthy of note. Despite the FRG's policy of not exporting arms to "tension areas", Euromissile signed a contract in 1978 worth $240 million with Syria for the supply of HOT and Milan missiles. The German firm, MBB, claimed that it only supplies components to Aerospatiale, which arranged the deal in conjunction with the French Government. Interavia, March 1978, p. 169.

[207]Boeing sold its 8.9% share of MBB in 1978, one which had since been watered down by the merger with Messerschmitt and HFB (Blohm). Aerospatiale still retains its share.

[208]"Euromissile . . .," op. cit.

[209]Ibid.

[210]MBB's Unternehmungsbereiche Apparate and Aerospatiale's Engins Tactiques divisions.

[211]"Euromissile . . .," op. cit.

[212]Boelkow's Cobra anti-tank missile was the first actual weapon system developed in the FRG after WWII, and attained major international sales success.

[213]Roger Facer, "The Alliance and Europe: Part III, Weapons Procurement in Europe—Capabilities and Choices," International Institute for Strategic Studies, London, 1975, Adelphi Paper No. 108, p. 48.

[214]"Euromissile . . .," op. cit., p. 470.

[215]International Defense Review, April, 1976.

[216]An outline NATO operational objective (OOO) is defined as "a broad listing of the operational characteristics required of the system. The document contains operational characteristics, details of the threat, desired capability and a general indication of size and cost limitations (if possible). Sufficient detail is given to enable pre-feasibility study(ies) to be carried out on the basis of the OOO."

[217]NIAG pre-feasibility studies are carried out by interested firms which are willing to contribute their expertise, largely at their own expense, in support of projects from which they see a real prospect of future business arising.

A pre-feasibility study is defined by NATO as a study indicating whether or not the outline NATO operational objective merits a deeper feasibility study. It is conducted to examine the proposal, assess the trade-off points and make a broad assessment of the practicable alternatives and also the penalties involved in adopting certain courses of action. The study should, so far as possible, establish the feasibility of suitable solutions consistent with the timescale of the study, identify problem areas and recommend the form and direction of the next phase.

[218]Thomas M. Lindberg, "NATO Second Generation Anti-Ship Missile—Business Evaluation," Boeing Aerospace Company, International Plans and Operations, September 16, 1976, p. 4.

[219]See Chapter 5 for more on NIAG.

[220]Lindberg, op. cit.

[221]Ibid., p. 5.

[212]Ibid.

[213]Document, NIAG(75)D/12 (Revised), August 12, 1976 entitled "Preparation of a Plan for Work-Sharing in Connection with the NATO Anti-Surface Ship Missile (ASSM) Project," pp. 2-3.

[214]NIAG(75)D/8, dated 15 May, 1975.

[215]NIAG(75)D/12 (Revised), op. cit., pp. 4-5.

[216]The NATO PHM project (Mode #5, Chapter 10) serves as an excellent example of the relevance of these particular concerns.

[217]NIAG(75)D/12 (Revised), op. cit., pp. 6-7.

[218]Ibid., pp. 7-8.

[219]Ibid., pp. 8-9.

[220]Ibid., pp. 9-10.

[221]Ibid., pp. 10-11.

[222]Ibid., p. 11.

[223]This is basically the same debate as that of the mid-60's, one centered at the governmental, not industrial, level, which involved a comparison of the two principal options open to the participating governments in joint projects: that of relying on a national executive agency as in the NATO Atlantic maritime patrol aircraft; versus that of their relying on an international executive agency as in the NATO F-104G, Hawk, and Sidewinder projects. Henri Masset summarized the pros and cons of this debate in his paper entitled, "L'Organization des Porivoirs Publics en vue de la Realisation des Programmes de Production Integree," presented at a colloquium sponsored by the Institut de Sociologie de l'Universite de Liege, in May 1965. The paper was published in 1967 by the above Institute along with those others presented at the same colloquium in the book entitled, Organization de Programmes Internationaux de Production Integree II. Pages 100-103 and 116 cover the main points of the issue.

[224]NIAG (75) D/12; op. cit., pp. 11-12.

[225]Summary Record, NIAG (76) (PC) R/2, NIAG Planning Group, Summary record of a meeting held at the NATO Headquarters, 11 May, 1976.

[226]A NATO operational objective is a statement, agreed by two or more nations, expressing in broad terms the functions and desired performance of a new weapon or equipment, before feasibility or method of meeting the requirement, or other implications have been assessed. Where a pre-feasibility study is envisaged, an outline NATO operational objective may be required.

[227]A feasibility study is carried out by industry or Government agencies or a combination of both with the object of providing a technical appraisal of the feasibility of developing and producing an equipment with the performance required by the NATO operational objective. The study identifies areas of

technical risk, recommends characteristics of the system(s) and gives the optimum balance between performance, cost and development time. The study also indicates areas where considerable advances on the existing state of knowledge are likely to prove necessary for successful development. It indicates the means by which the recommended solution will be achieved, suggests a program for project definition, development and production, with a preliminary estimate of the costs for these phases.

[228]A NATO operational requirement is a document that represents the results of the refinements of the NATO operational objective as a result of an agreement upon trade-offs between feasibility, cost, operational needs and national requirements and taking into consideration the NATO Military Authorities' (NMA) advice and recommendations. It represents the final specification of the system upon which project definition is based.

[229]Lindberg, op. cit., p. 6.

[230]Ibid.

[231]Ibid., pp. 7 and 11.

[232]Ibid., p. 15.

[233]Ibid.

[234]Ibid., pp. 15-16.

[235]Euromissile, ASEM, and ATEM—nuclei of a future European guided missile industry?", International Defense Review, 3/1977, p. 470.

[236]Ibid.

[237]Ibid.

[238]Ibid.

[239]Lindberg, op. cit., p. 16.

[240]Ibid., p. 17.

[241]Ibid., p. 18.

[242]Although the Belgian Navy had originally stated a requirement for 15 tri-partite minehunters only ten of these will be built in the immediate future. Originally, two private consortia tendered for the Belgian contract, one a combination of the well known Cockerill and Boelwerf yards, the other a joint group of smaller yards. However, it proved possible to combine the two consortia. Between them they have formed a special company called Polyship to build the ships. A new ship construction facility is being built along the lines of Van der Giessen-de Noord's.

[243]Yves Robins, "The Tri-partite Minehunter Program," NATO's Fifteen Nations, October-November 1979, p. 80.

[244]The inherent advantage of minehunting over minesweeping is its far greater efficiency. It is possible to replace a given number of minesweepers by a smaller number of hunters without incurring any loss in operational effectiveness. Since the 1950s, all three participating countries had already decreased the number of MCM vessels in their fleets, because of the cost of maintaining such large numbers of ships and the conversion of limited numbers of sweepers into hunters. (van Kuffeler)

[245]F. de Blocq van Kuffeler, Captain, Royal Netherlands Navy (retired), "The Tri-Partite Minehunter: a model for international cooperation, "International Defense Review," 9/1978, p. 1472.

[246]Ibid., p. 1474.
[247]Robins, op, cit., p. 80.
[248]van Kuffeler, op. cit., p. 1473.
[249]Ibid.
[250]Robins, op. cit, pp. 81-84.
[251]Ibid., p. 84.
[252]Ibid.
[253]Ibid.

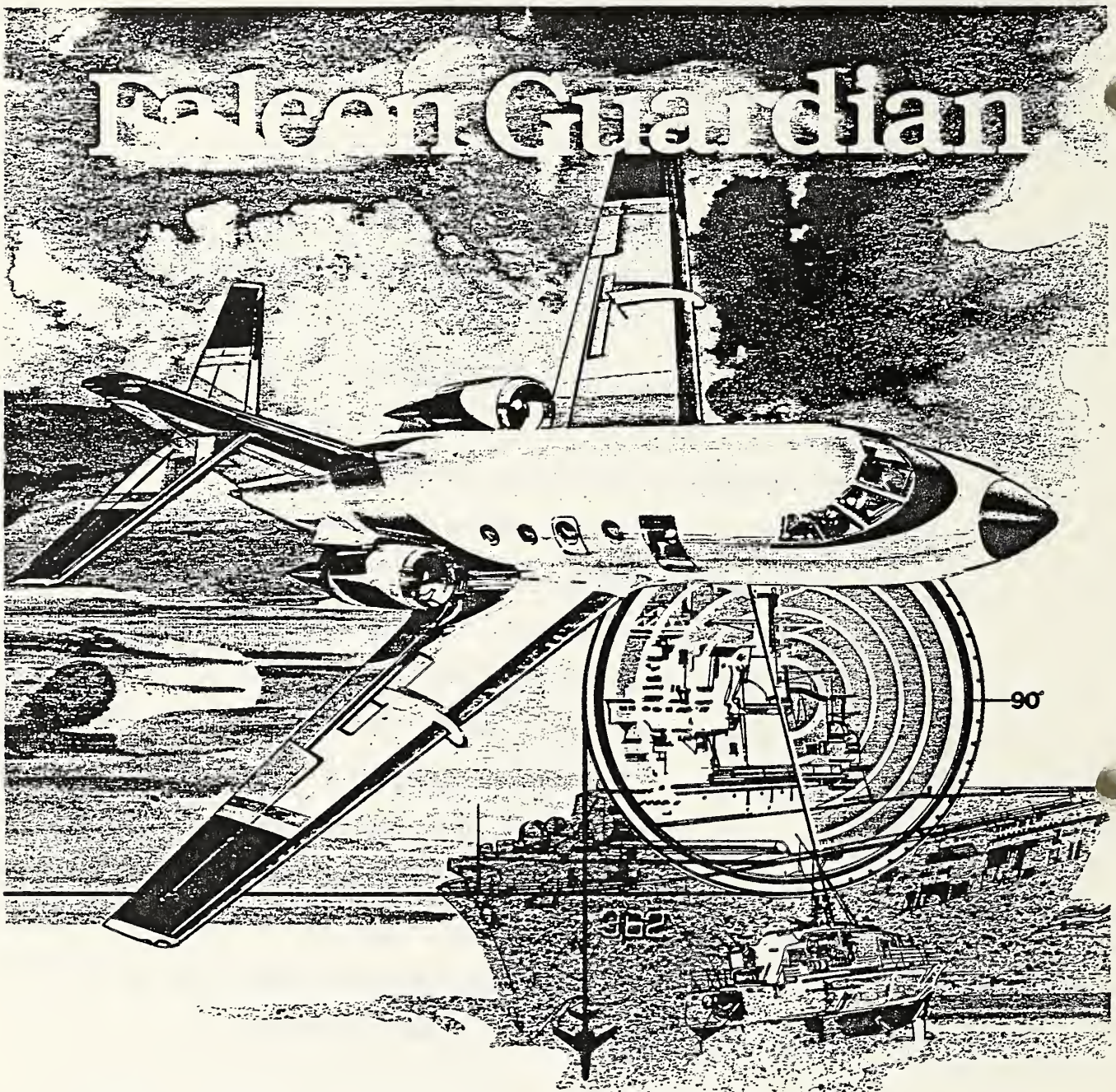
Chapter 9

MODE #4 — Production of a European Developed System in the U.S.

A. Introduction

This chapter represents a look at the narrower of the two lanes in the "two-way-street" issue, i.e., the procurement of a European developed system by the U.S. This is accomplished through resorting to a range of possibilities that includes, at one end of the spectrum, direct purchase of the systems on an off- the-shelf basis, toward the middle of the spectrum, the production of a more or less 'Americanized' version of the system in the U.S. (either under license or by a U.S. affiliate or subsidiary of a European firm), and at the far end, the development of an advanced version of the system on the basis of the purchased data package. Most of the systems involved in this Mode are a mixture of two of the above options and, in the case of the Harrier V/STOL fighter, involved several years of transatlantic co-development, the other major Mode for transferring European technology to the U.S.

The off-the-shelf aspect of procurement is not within the scope of this paper except as it is involved with one of the eight Modes of industrial collaboration covered herein, and the further development in the U.S. of an advanced version of a European system is currently only used on a very limited basis. (The Harrier is the only significant case.) The five major cases of direct purchase over the last decade are: the USMC's Harrier, the USN's OTO Melara 76mm/62 caliber dual purpose gun, the USA's Mag-58 armor machine-gun, the



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USCG's 41 Falcon medium range surveillance aircraft, and most recently the USAF's Rapier SAM system for its UK bases. With regard to off-the-shelf procurement by the U.S. of a European-developed system, there is the assumption that the historical trend of only minimal use of this option will continue in the future with only a minor increase, since the obstacles to a major expansion in the use of this option will most certainly continue to apply in the future as well (e.g., Balance of Payments (BOP), and employment barriers). Therefore, to reiterate, the focus here is on the unique set of problems encountered, the lessons learned, and the arrangements developed through operating within the constraints of the Mode of licensed production of a European-developed system in the U.S.

There has been an easily discernible trend away from direct procurement among the developed members of the North Atlantic Alliance over the last two decades. The alternatives that have been increasingly utilized have involved assorted Modes of industrial participation or compensation for the purchasing nation. Several of the most significant factors contributing to this are:

- The phasing out of Military Assistance Program (MAP) concurrent with full economic recovery in Europe in the late 50s.

- The natural importance attached to the 'secteurs de point' in national economic development policies.

- The increasing priority attached to social goals (e.g., increasing demand for government-funded social welfare services and employment stability)

combined with a lessening of the "perceived" Soviet threat on the part of the general populace during the 1960s.

- The increasing cost of developing and producing modern weapon systems.

- The end of the abrasive troop offset agreements between the U.S. and the Federal Republic of Germany (FRG) in the early 70s - representative of an underlying evolution of attitudes in the FRG and a new international monetary order (wherein the BOP issue is less of an immediate concern for the U.S.).

As a result of these developments, there has been a more or less unilateral effort on the part of the Europeans to lessen the imbalance in the trans-atlantic flow of arms and related technologies. With the winding down of U.S. involvement in South East Asia in the early 1970s, the U.S. became more cognizant of this trend and decided to swim with the current in the interests of alliance solidarity.

In correcting this imbalance by acting to support the "two-way street" concept, one can attack the problem from two directions. One approach is to act so as to decrease the breadth of the U.S.-to-Europe lane (in response to the interrelated industrial production, employment and BOP considerations) by license production and various forms of and internal and external industrial offsets. But then Europe, especially the larger nations, cannot be easily assuaged by these nor by technology import considerations, as was the case in the early 1960s.

The other approach, of course, involves acting on the Europe-to-U.S. narrower lane in such a way as to broaden it. This could involve greater direct purchases from the Europeans as well as licensed production. Since this area of economic activity involves the art of the politically feasible, or satisficing, the mix of these two approaches would naturally be weighted toward the latter.

During the latter half of the 1970s, the U.S. has acted primarily on the broader lane with such major programs as the F-16, AWACS, the Patriot, Copperhead, MLRS, and the AIM-9L Sidewinder (Modes #7 and #2 of industrial collaboration). The NATO Seasparrow project (Mode #5) acted on both lanes, while the direct-purchased Harrier, Mag-58 gun, OTO Melara naval gun,[1] Rapier, Falcon and the production of versions of the Roland II and Dauphin II in the U.S. concerned the narrower lane. Due to the across-the-board U.S. development capability (resulting from its greater technological, financial, and industrial resources) and its role as a world power, it has been easier in the short run to act on the U.S.-to-Europe flow of traffic than on the opposite flow. The Europe-to-U.S. flow is where greater effort will have to be made, especially in the less politically vulnerable area of licensed production, if the DoD and the last three Administrations' endorsements of the "two-way street" concept is to become more meaningful over the long run.

Traditionally, the word standardization in its NATO context has implied a one way street, i.e., the European members of the Alliance should select the highest quality and cheapest equipment, which in turn has meant usually buying from the U.S., or at best producing U.S. systems under license. Ignoring

implications for the wider national technological bases, there also is the factor of offsetting the cost of U.S. troops stationed in Europe by buying U.S. equipment - a factor not just bearing on BOP but with strong industrial and technology considerations as well, and involving primarily, but not exclusively, the US-FRG relationship. As such, the traditional use of the word "standardization," especially by the U.S., has called to mind something on the order of the rational relationship that exists in the Warsaw Pact. But as the French in particular, and the other European allies as well, are prone to point out, the North Atlantic Alliance is one of fully sovereign nations, whereas the Warsaw Pact is an alliance wherein limited sovereignty is the rule. Emanating from centuries of political history, the basic fact of sovereignty does not allow for any rationalization scheme that would result in a specialization of industrial and technological capabilities, dividing work up between nations such that it would result in a monopolistic dependence of one upon the other for a given system. Nor is any sovereign nation going to allow a supranational authority or mechanism to select these systems for it, again because this impinges substantially upon sovereignty. As of the early 1980s, the previous points are all generally accepted on both sides of the Atlantic, but they were brought up here as a reminder that they were not always so, and still aren't in some quarters. The point here, then, is simply the necessity of avoiding those tempting, facile short-cuts in logic that ignore basic political realities.

Hence, the primordial importance of orienting our policies towards the feasible, which, as brought out in the conclusion of Chapter 5, means two things: first, placing the accent on the 'I' for interoperability in the

acronym 'NATO RSI', especially at the transatlantic level; and second, where a degree of the preferable but more elusive option of standardization (or the 'S' in NATO RSI) is feasible, more of a "two-way street" in the transatlantic flow of arms and related technologies, which often means settling for interchangeability at the subsystem and component levels.

The second point, and a feasible response to it, is the underlying issue with which this chapter is attempting to deal.

Over the years the U.S. military departments have occasionally purchased foreign hardware and had foreign-developed equipment produced in the U.S. From a quick glance at a sample of these, it is readily apparent that few such programs have been initiated specifically in response to a stated need to acquire and utilize foreign technology per se. Rather, the impetus has usually been a need to satisfy a military requirement for an operational piece of hardware in less time than the normal R & D cycle would allow, whether due to an urgent war-related need, or one of those rare instances where there was a major need for which no comparable U.S. equipment would be available for a considerable period. The time factor in such cases was deemed to be of sufficient importance to overide the normal approach. This normal approach included, among others, the major barrier represented by that all too visible target of critics of U.S. NATO policy, the 'Buy American Act.' With the new State/Defense NATO RSI policy and the pervasive influence of the "sense of the Congress" expressed in the Defense Appropriation Authorization Acts of 1975, 1976 and 1977, as amended, this has now apparently changed, at least with

regard to our NATO allies.[2] We will hopefully see more tangible results from this policy over the next few years.

The projects referred to in this chapter that involve a transfer of technology for the production in the U.S. of a European system, include: the British Canberra bomber (B-57) in early 1950s; the Dutch WM/22 Gun FCS (MK-87) in the early 1960s; the French RATAC ground surveillance radar (AN/TPS-58) in the late 60s and early 70s; development of an advanced version of the British Harrier V/STOL strike fighter since the early 70s; the Franco-German Roland II short range air defense missile system; and since the mid-70s the French SA 366 Dauphin II helicopter and the British and Franco-German competitors for the VTX-TS. The Canberra, WM/22 FCS, the Harrier, the SA 366 and the VTX-TS, are only covered briefly while the RATAC and Roland systems, especially the latter, are covered in greater depth.[3]

These cases, involving primarily the U.S. acquisition of a European developed system through licensed production, have encountered considerable difficulties. These projects were often hindered by the general lack of U.S. experience with such arrangements, due to the rarity of their occurrence, as well as by those stemming from the particularities of the European and American industrial bases in the areas of design, drawings, technical procedures, tooling, production technology, processes, and standards of performance, safety and maintenance. There is also the difficult problem of reaching that balance in the proper amount of Americanization and the degree to which the design had fully matured and been stabilized prior to transfer.

On this latter point, these projects were successful from a purely national viewpoint in eventually reproducing the system in the U.S., though with some cost and schedule problems. Yet, in terms of NATO Standardization and Interoperability, the purely national focus in the meeting of immediate military and economic needs has resulted historically in marginal results. Modifications were made in the original systems with little or no concern for their bearing on the total NATO defense posture. When the implications vis-a-vis NATO finally were given greater attention in 1975 and 1976, the U.S. Roland project was caught in the policy shift, which meant encurring the concomitant cost and schedule problems which accompanied redirection of the project.

B. British Canberra Bomber

The English Electric Canberra bomber was flown by some 16 air forces world-wide, with a total of 1,398 being produced in the UK (925), Australia (49), and the U.S. (424).[4] The Canberra, which first flew in 1949, was selected in 1951 during the Korean War by the USAF and was still flying in the early 80s. The U.S. bought two Canberras and the technical data package with the intention of bypassing the usual development time and U.S. design criteria by using the two as test vehicles and models to determine minimum engineering modifications necessary to produce an American version of this two-man bomber that was originally intended to be very close to the original. The American version was designated the B-57, and The Martin Company was the contractor selected to do the job. On the way to Martin's Baltimore, Maryland, plant, the first of these two Canberras was flown from Aldergrove, Northern Scotland, to Newfoundland on February 21, 1951, in 4 hours and 37 minutes, representing the first crossing of the Atlantic by a jet without refueling.

The Canberra project originated in 1945 with the issuing of a specification by the Air Ministry for a fast high-altitude bomber powered by jet engines. The first prototype made its maiden flight in May 1949. The aircraft was powered by two Rolls-Royce Avon 101 turbojets and was structurally simple, offering great reliability and flexibility of use, with extremely good handling and all-around characteristics at high altitudes.

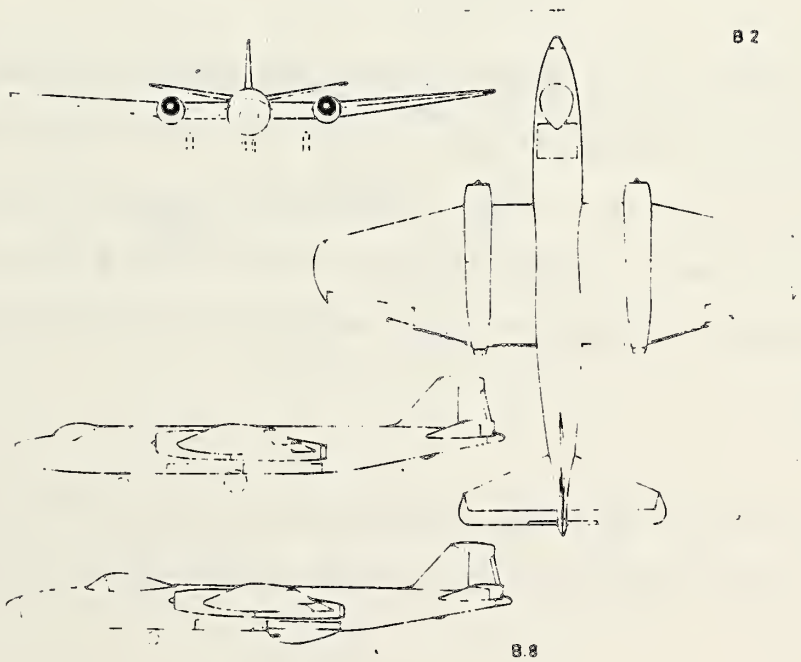
Prior to the time when the U.S. decision was made at the beginning of 1951 to procure the aircraft, the USAF had been looking for a reliable assault

1950 – English Electric Canberra B.2 GB



GB English Electric Canberra B.(1)8 – 1954





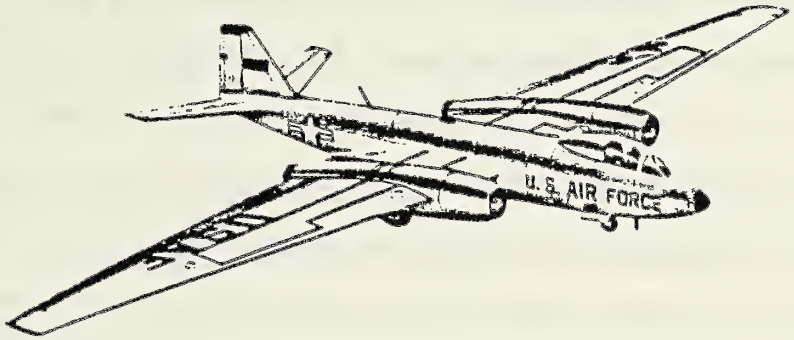
Source: Rand McNally

aircraft. Faced with the failure of the Martin XB-51 project in 1949, the USAF saw the Canberra as the best alternative for its own needs. Quoting from Rand McNally's World Aircraft, "In its roles as an assault and reconnaissance aircraft, this originally British twin-engined aircraft has shown itself to be an excellent aeroplane in the USAF. Its brilliant operational service has roundly contradicted all those who had first treated the decision to use a foreign combat aircraft with suspicion."[5]

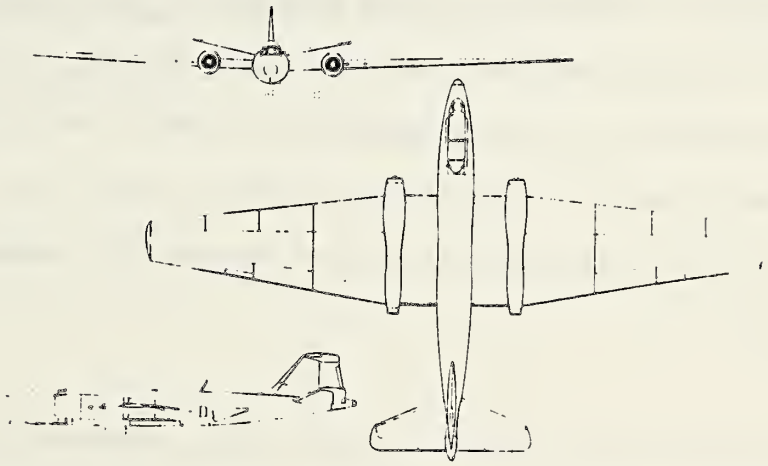
From the two purchased aircraft, Martin started up its initial production, building eight B-57As which were essentially identical to the British prototypes, except in the case of certain structural parts where it was necessary to adapt to U.S. manufacturing standards. More will be said on this shortly. The first B-57A flew in July 1953, and initial production was followed by 67 RB-57A's, a reconnaissance version which was almost the same as the preproduction aircraft. The RB-57A started to reach the squadrons in April 1954.[6]

Two months later the prototype of the B-57B version made its maiden flight and was an aircraft that was to serve in the role of a "night-raider." In this aircraft the first of a series of substantial modifications to the British version was made.[7] In January 1955 the first of 202 B-57Bs started to reach the operational squadrons.[8] Later versions built for the USAF under license included:

38 B-57C trainers; 20 RB-57D reconnaissance aircraft,[9] 68 B-57E target-towing aircraft, and 21 RB-57F[10] high altitude reconnaissance aircraft.[11]



USAF/Martin B-57



Source: Rand McNally

As the first major case of the production in the U.S. of a foreign system since the French 75mm artillery piece during WWI, the Canberra proved to be one of the most problematic of the U.S. acquisitions of a foreign-developed system through licensed production. The technical data package produced immediate complications. It contained British third quadrant projections as opposed to first quadrant projections as is standard in the U.S. British configuration management and control techniques being still somewhat primitive, drawing specifications were often seriously out of date and thereby caused major problems in matching drawings to existing aircraft hardware and in ordering ancillary equipment. Auxiliary equipment ordered by using advertised specifications was often dissimilar to the actual hardware received.[12]

Differences in terminology caused problems in understanding design intent and analysis. Tests indicated that design analysis had been very loose by American standards, and consequently basic tests and stress analyses had to be conducted as soon as a questionable item was identified. An entire analysis of the aircraft was required in order to ascertain adequate margins for design safety.[13]

British designs were found to include subtle differences such as milling thicknesses of metals, bend-radii in metals, edge margins on rivets, and countersinking requirements and techniques. The U.S. had more stringent requirements than the British for edge differences on fastener holes, stiffener spacing for sonic environment, design fitting factors, control system design factors, fatigue design, process tolerances, and single engine performance. A major effort was required to select materials specifications

that would have equal or better characteristics in all facets of ultimate yield, elongation, corrosion resistance, and fatigue properties and be within the constraints of variations of standard thickness gauges, bend-radii, heat treatments, and differences in physical property testing techniques.[14]

More extensive personnel interchanges and liaison became necessary because of the differences in drawings, technical jargon, inspection techniques, and production philosophies. Complete new sets of drawings, analyses, handbooks, manuals, and technical orders had to be produced in order to make the aircraft both producible and supportable within the U.S.

In short, the aircraft was redesigned. With the B-57 and its main features having been completely "Americanized", all that remained of the original Canberra was its silhouette.[15]

[1]The U.S. ammunition for this gun was redesigned and is not interoperable with the Italian gun.

[2]GRC, op.cit., P. A-10.

[3]Two other recent foreign procurements, the Belgian Fabrique National Mag-58 armored machine gun and the German Rheinmetall 120 mm tank gun for the XM-1 are both treated in Chapter 11 dut to there being some evidence that their procurement was tied, at least in part, to the purchase of other systems. The Mag-58 gun was to later involve production in South Carolina by a U.S. subsidiary of Fabrique Nationale.

[4]World Aircraft: Military, 1945-1960, Rand McNally and Company, Chicago, 1978, P. 88.

[5]Ibid.

[6]Ibid.

[7]It is important to remember that the British themselves were also continuing to modify their Canberras in parallel, though neither nation felt the need to coordinate these two separate evolutionary processes.

[8]The modifications of the B-57B included: the installation of a cockpit that could accommodate the two crew members in tandem rhater than side-by-side; the installation of machine guns in the wings; and the capability of carrying rockets.

[9]The RB-57D involved further substantial redesigning of the basic type, with considerably increased wingspan to improve high-altutide performance and replacement of the Rolls Royce Avon engines with Pratt & Whitney J-57s. As well as photographic reconnaissance, these aircraft were also used for electronic countermeasure misisons.

[10]These RB-57Fs were built by General Dynamics in the mid-60s and involved substantial modifications to the wing, fuselage tailplane, and instrumentation.

[11]World Aircraft, op. cit., p. 89.

[12]General Research Corporation (GRC), NATO Standardization and Licensing policy - Exploratory Phase, Vol. II — Main Report, (hereinafter referred to as GRC (1976)) Mclean, Virginia, Nov. 1976. (First Edition) p. A-11.

[13]Ibid.

[14]Ibid.

[15]Ibid, p. A-12.

C. Dutch WM/22 Gun FCS

In the early 1960s the USN decided to upgrade its existing gun fire control systems (FCS) in use on various ships through Americanizing a Dutch system, the WM/22 Gun FCS. The fire control system was one that had been built around a NATO specification (i.e., a standardization agreement) (STANAG). Sperry Rand was selected by the USN to produce a modified version of the original. This was accomplished in an estimated 12 to 18 months less than it would have taken the U.S. to develop and produce a comparable system, but at a cost estimated to have been 41 percent more.

Developed by Hollandse Signallaparaten (HSA), many of the electronic components of the WM/22 had been procured in the United States. The Navy originally was going to buy the technical data package and eight units but later reduced the purchase to two complete units. Sperry Rand was awarded a cost-plus-fixed-fee contract in September 1964 to "Americanize" the two Dutch units into a system to be known as the MK-87, MOD 0 Gun Fire Control System.[16]

The licensee set out to manufacture the MK-87 within the constraints of the original contract. The acquisition of data proved difficult primarily because of the methods employed by the Dutch in transferring the drawings. The material received from the Netherlands consisted of large bundles of drawings, some of which were old, out of date, and in some cases not even related to the WM/22.

Costly identification of applicable drawings was required. One million dollars was expended in updating the drawings and schematics, and $3 million was spent on translation. Throughout the process, Sperry made an additional effort to secure basic physical configurations by making photographic reproductions of the equipment and components to supplement the drawings.[17]

Since the entire program involved the "Americanization" of only two systems, no large tooling effort was required. Sperry converted foreign design parts to American equivalents, retaining overall envelope dimensions. The transfer of know-how was implemented by an exchange of management personnel and engineers. Resident engineers from HSA were present at Sperry, and Sperry's technical and management people maintained liaison representatives at HSA in the Netherlands.[18]

Sperry also queried vendors to determine what dimensioning system was preferred. When a preference for Anglo-Saxon units was expressed, Sperry carried out the conversion itself and controlled it by in-house computers in an attempt to reduce vendor interface errors.[19]

The two systems fabricated to the Dutch design were subsequently subjected to "in-plant" tests, land-based tests, system integration tests and finally technical evaluation, and the tests authenticated producibility. After operational evaluations of both units were completed, they were deployed to Vietnam, from where they were subsequently returned to the Long Beach Naval Shipyard in 1971 for modification to include Interim Surface-to-Surface Missile Capability (ISSMC).[20]

Although the HSA WM/22 FCS never entered series production in the U. S., a subsequent model, the HSA WM/28, was selected in 1972-73 time frame for use on the NATO PHM Hydrofoil and USN's FFG-7 class of frigates. The existing Dutch-American industrial working relationship was expanded upon, when Sperry Rand was once again selected to produce the Americanized version of the WM/28, the MK 92, under license from HSA - (See Chapter 10 for details of how the WM/28 system entered the U. S. inventory via NATO PHM project.)

[16]GRC, op. cit., p. A-12.
[17]Ibid.
[18]Ibid., p. A-13
[19]Ibid.
[20]Ibid.

D. The British AV-8A Harrier and the Anglo-American AV-8B

In part due to the operational demands of the war in South East Asia, the Pentagon's R&D budgets over the second half of the 1960's and the early 70's were austere. Consequently, the development of new systems was severely limited and the Europeans were able to develop several major systems for which there was no U.S. counterpart. Two of these were the Hawker Siddeley Harrier Vertical Takeoff and Landing (VTOL) strike fighter developed in the U.K., the Roland SAM system developed in France and the FRG.[1]

1. The British Persevere as Allied Interest Comes and Goes (1958-1969).

Hawker Siddely had begun design work on the VTOL aircraft that was to ultimately become the Harrier, back in 1958. Originating as a private venture, the project quickly acquired the support of the British government.

The project subsequently received U.S. government funding support as well in the early 60's. U.S. funding was through the DoD's Mutual Weapons Development Program (MWDP) which had supported the design and development of a number of European systems including the NATO Fiat G-91 Lightweight Strike Reconnaissance (LWSR) fighter and the Dassault Etendard fighter (see Chapter 5), the NATO Breguet Atlantic maritime patrol aircraft (see Chapter 5), and the Franco- German LCT RATAC ground surveillance radar (see Chapter 9). Out of a total of $80 million spent on VTOL fighter development by the U.S. government during the 1960's, $50 million was to go into two consequtive British VTOL projects, the P-1127 and Kesterel.

Six VTOL prototypes were built by Hawker Siddley under the designation P.1127 in the early 60's. The P.1127 was to be the RAF's candidate for the aborted NATO Basic Military Requirement (NBMR) 3 design competition sponsored by NATO in 1961 (see chapter 5).

The six P.1127's were followed by the nine Kestrels, an improved version powered by a 15,200 lbst. engine. The Kestrel program, jointly funded by Britain, FRG, and the U.S., saw the formation of a special tripartite squadron composed of personnel from the three interested nations which during the 1965-66 time-frame, evaluated the Kestrel under a variety of operational conditions. Following this, six Kestrels, designated XV-6A, were sent to the U.S. for further evaluation, where they were judged to be underpowered.[2] While the Kestrel demonstrated the feasibility of the concept, its engine suffered from an insufficient thrust to weight ratio which seriously limited the payload.

In the meantime the U.S.A.F. had also dropped out of its separate joint design project for a VTOL fighter with the FRG, the AVS program (see chapter 10)[3], having put the VTOL fighter requirement on the shelf where it has been left to collect dust over the last 15 years.

Development of the Pegasus 10 engine, however, led to continued work in the U.K. on a subsonic version under the name "Harrier." Benefiting from six years of operational experience with the P.1127 and the Kesterel, the first of six single-seat prototypes flew in August 1966. This effort was rewarded the following year with initial RAF orders for a sixty aircraft program. First

operational in April 1969, two Harrier squadrons were assigned to NATO duty, dispersed in hidden sites in Northern Germany.

2. The U.S. Finally Steps Forward but Licensed Production in the U.S. is Dropped in Favor of an Off-the Shelf Purchase.

Even though the U.S.A.F. had lost interest in a VTOL fighter, the interest of the U.S. Marine Corps intensified in the late sixties when evidence of the potential of the greatly improved Harrier was demonstrated. The U.S.M.C., unlike the U.S.A.F., gave a much higher priority to the specific mission of ground support, and was intrigued by the operational deployment flexibility offered by a VTOL fighter. In 1969 the Navy requested FY 1970 funding for 12 Harriers for Marine Corps test and evaluation.

The request was approved and, an initial quantity of 12 Harriers was purchased off-the-shelf from Hawker Siddeley at a cost of $48 million. The Marines took delivery in January 1971 at the Hawker Siddeley plant in the U.K. The Harriers then had their wings removed and were loaded on C-141's and shipped to the Naval Air Test Center, Patuxent River, Maryland. If the aircraft proved to be effective after its evaluation, the Marines were hoping to obtain funding from Congress for the procurement of at least another 100.[4]

A condition placed by the Congress on the sale agreement for the first 12 Harriers was licensed production in the U.S. of any future follow-on order. The interest of U.S. firms in obtaining license rights was centered primarily around the technology to be gained in V/STOL fighter techniques, rather than any immediate profit in the expected production run of some 100 aircraft.[5] Following the decision on the order of 12 aircraft, a licensing agreement was

finalized between Hawker Siddeley and McDonnell Douglas.[6] Rolls Royce and Pratt & Whitney reached similar arrangements for possible U.S. production of the Harrier's Pegasus engine.

In order to provide enough aircraft for one complete squadron and a training nucleus, the Marine Corps proposed, in its Fiscal Year 1971 budget presentation to Congress, an order of 18 more Harriers to be procured at a cost of $118.3 million ($96.2 for the aircraft, and $22.1 million for initial spares). The DoD also included an additional $24.2 million to provide for the cost of assembly of the 18 Harriers in the U.S. by McDonnell Douglas of knocked down aircraft purchased from Hawker Siddeley. McDonnell Douglas was to build up to a full airframe production capability by 1975.[7]

In the end, however, Congress balked at paying a premium for licensed production, reversed its position, and decided on an off-the-shelf purchase, one that ultimately totaled 110 aircraft through fiscal year 1974.

3. Further Development: At First Jointly, Followed by Two Unilateral Programs. In lieu of licensed production, the DoD opted to purchase the aircraft off the original line and to utilize the technical data package (TDP) to continue development in the U.S. At least initially, there was to be a joint program with the U.K. for the development of an advanced version of the Harrier. This can be contrasted with two other cases: the unilateral approach adopted for the modification of an earlier British Aircraft, the Canberra (USAF B-57) prior to start up of production in the U.S.; and modification (i.e., Americanization)

of the Roland II, while maintaining International Interchangeability with the European version.

The first Anglo-American studies for an Advanced Harrier began in 1973. They were referred to popularly by the designation AV-16 (implying twice the capability of the AV-8A).[8]

The effort foundered in March 1975, when the British government dropped out of the joint program, declaring that there was "not enough common ground" between the U.S. and U.K. requirements.[9] The British decided to put their efforts into a more modest modification of the original aircraft, while agreeing to the continued development of the advanced version, the AV-8B, on a unilateral basis by the U.S. (This would involve British participation in any production of the AV-8B as the major subcontractor.)[10]

With McDonnell Douglas and Hawker Siddeley (soon to become part of British Aerospace) each pursing their separate lines of development, both were aiming broadly at doubling the payload/radius capability of the first generation Harrier. This objective was to be attained without departing too radically (or expensively) from the existing airframe/engine combination. Both nations' proposals involved the use of a brand-new supercritical wing.[11]

By July 1976, work at McDonnell Douglas had progressed to the point where the Pentagon authorized the development and testing of two prototypes of the Advanced Harrier to be built under license by McDonnell Douglas, designated the YAV-8B.

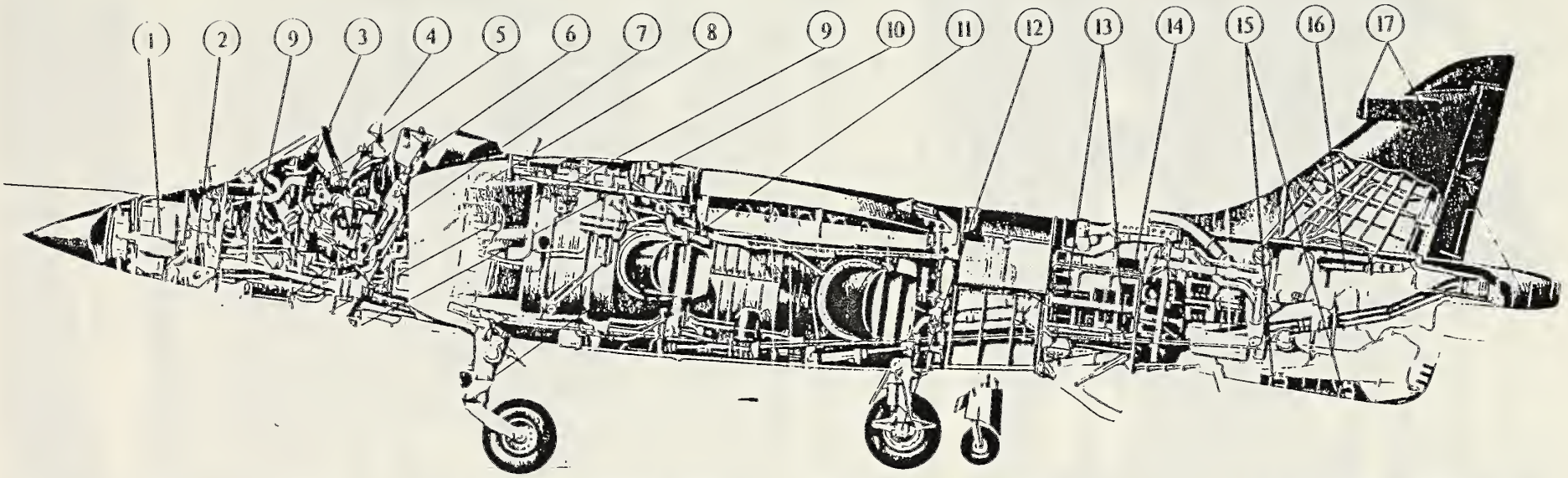
The first phase of the Defense Systems Acquisition Review Council process was followed by a six-month contract definition period and the two-aircraft YAV-8B flight demonstration program. Rolls Royce further modified the Pegasus engines to increase their thrust, and British Aerospace (BAe) built much of the airframe. The first flight of these prototypes occurred in the latter part of 1978.

Features of the American design are the use of: graphite epoxy (carbonfibre composite materials) for the wings; outrigger fairings, and tailplane; redesigned air intakes to provide more VTO/STO thrust and more efficient cruise; and the Hughes Angle Rate Bombing System developed for the A-4M Skyhawk.[12]

Starting in FY'78 the U.S.M.C. began its Conversion in Lieu of Procurement (CILOP) program. The AV-8A's were to be converted at the rate of 10 per year to AV-8C's. Among the modifications were multiple carriage stores, vertical take-off lift improvement devices, electric fusing and the ARC-159/KY-28 radio. Survivability features include a radar warning receiver, and an integral flare and chaff dispenser.

For their part, the British followed a different tack with the launching in 1975 of a program aimed primarily at designing a new wing for the Harrier. The new wing was larger and could have been retrofitted with very little modification to existing Harriers. The new aircraft was designated the Harrier Mk.5, and in common usage was referred to as the Big Wing Harrier. For their requirement, the British placed greater weight on air-to-air combat and the greater maneuverability essential for European deployment. (The primary mission of the U.S.M.C. Harriers was ground support of troops, i.e., air-to-ground.)

How we turned a basic Harrier into a Sea Harrier.



1. We installed Blue Fox multi-mode radar.
2. We fitted a folding nose for hangar stowage.
3. We gave the pilot's HUD a larger field of view.
4. We raised the cockpit.
5. We improved the cockpit layout.
6. We fitted a Mk 10H Ejection Seat.
7. We fitted Doppler Radar.
8. We redesigned the wiring, introducing lightweight cables, digital data highways and advanced EMC-immunity.
9. We ensured easier maintainability.
10. We added an I Band Transponder.
11. We built in storm lashing points.
12. We provided independent emergency brakes.
13. We installed digital navigation and weapon aiming computers.
14. We introduced an autopilot.
15. We fitted a radar altimeter.
16. We increased the tailplane authority.
17. We added a radar warning system.

In addition, we improved corrosion protection throughout, particularly in the engine.

We replaced magnesium alloys.

We catered for air to air and air to surface missiles.

We strengthened the weapons stations.

All because a basic Harrier on a deck full time is, literally, out of its element.

Getting the best out of V/STOL at sea takes a whole new Harrier. This one.

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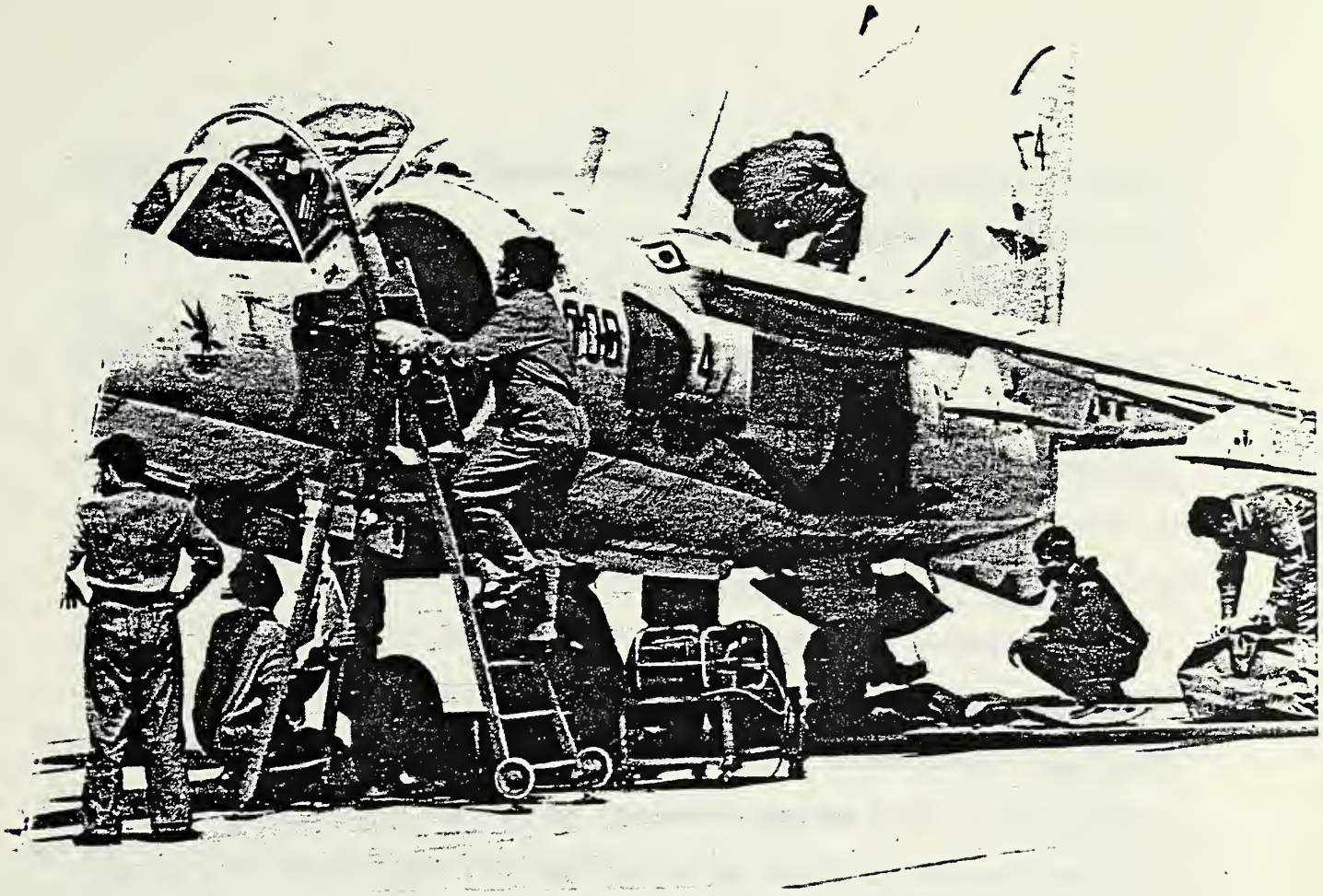
In the end, some six years later, the British government decided to order the U.S.M.C. AV-8B, but one modified by the addition of British-designed, maneuvrability-increasing LERX (leadiwo carriers during the Falklands Conflict, 2 Royal Navy Sea Harriers and 3 RAF Harrier GR3's were lost. In return they were credited with knocking down 31 Argentinian aircraft (24 with AIM- 9L's and 7 with the 30mm Aden gun). Several months later, in part to make up for these loses, the U.K. MOD gave BAe authority to proceed with the production of 14 additional Sea Harriers. This brought total Sea Harrier orders by the Royal Navy up to 48 aircraft.

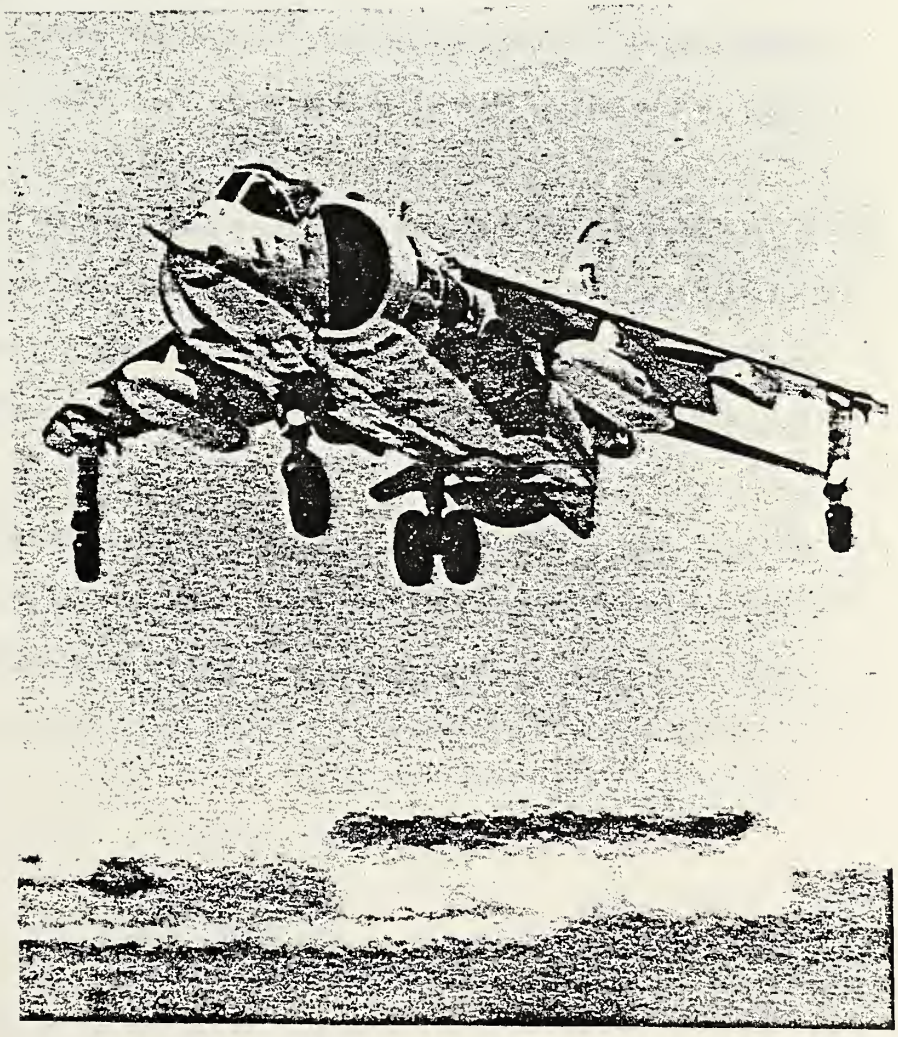
4. The AV-8B and the Debate in the U.S. (1977-81): The Carter Administration and the Navy versus Congress and the U.S. Marine Corps

The AV-8B project found itself at the center of a debate over the age old issue of the economies offered by standardization (at both the conflicting intra-and inter-national levels) versus specialized requirements and the imperative of technological development.

A light attack aircraft, the U.S.M.C.'s Advanced Harrier's missions were to include close air support, battlefield interdiction and close-in fighter defense from austere bases ashore and a variety of ships from sea.

The system was to have twice the payload and range of its predecessor, the AV-8A. Airframe changes for the advanced version include a weight-saving supercritical wing made from graphite epoxy, a raised cockpit to improve visibility, larger wing trailing-edge flaps and dropped ailerons, redesigned





Spanish Deploying AV-8A

British Aerospace AV-8A Matador of the Spanish naval air arm lands at the Spanish naval air station at Rota, Spain (right). The aircraft, piloted by Lt. T. N. Montaner, had completed a three-day tour on board the Spanish aircraft carrier Dedaldo. Post-flight check on a Matador (above) is carried out at Rota by a Spanish navy crew. Large maintenance facilities for the aircraft are located here, with half the Matador force normally at Rota and half on board the Dedaldo.

engine air intakes, the addition of under-gun-pod strakes and a movable flap panel to improve vertical lift.[15]

The Marine Corps' aim was to acquire the AV-8B to replace its British Aerospace AV-8A's and eventually its McDonnell Douglas A-4Ms, and F/A-18s to replace its McDonnell Douglas F-4s.

a. The Fiscal Year 1979 Budget. Within its first year in office, the Carter Administration, in reassessing military and budget priorities, attempted to cancel three major programs inherited from the prior administration two of which were interallied. The first one, the NATO PHM, had its funds impounded in the spring. After 45 days, however, as Congress had not adopted a rescission bill, the president had had to release the funds (but not until after the damage had been done, the Germans having withdrawn in the meantime). The B-1 bomber program was to fall to the same ax several months later.

That summer, rumblings were heard on Capitol Hill that the Carter Administration had also targeted the AV-8B program for termination. Defense Secretary Harold Brown decided to halve the Marine Corps request of $173 million, and held Harrier funding in the fiscal 1979 request to $85.6 million.

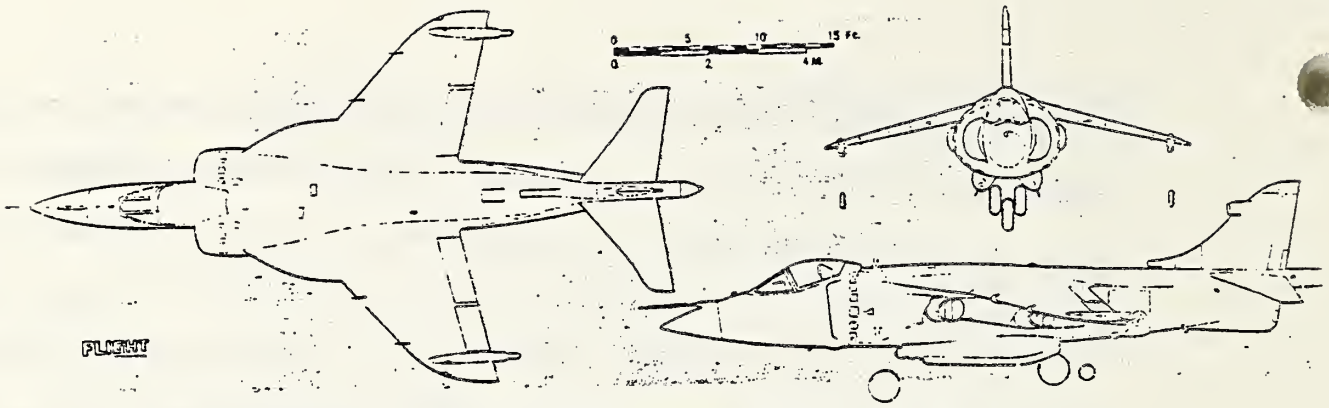
Marine Corps aviation continued to struggle within the Pentagon to keep the project alive, while attempting to minimize damage to the U.S.Navy's conventional aircraft carrier, and the McDonnell Douglas/Northrop F-18 fighter and its A-18 attack version.[16]

Initially, the Marines were ordered to complete an attack aircraft cost and effectiveness comparison for presentation to Defense Secretary Brown on November 1, but it later was moved to the secretary of the Navy's office for programs and analysis.

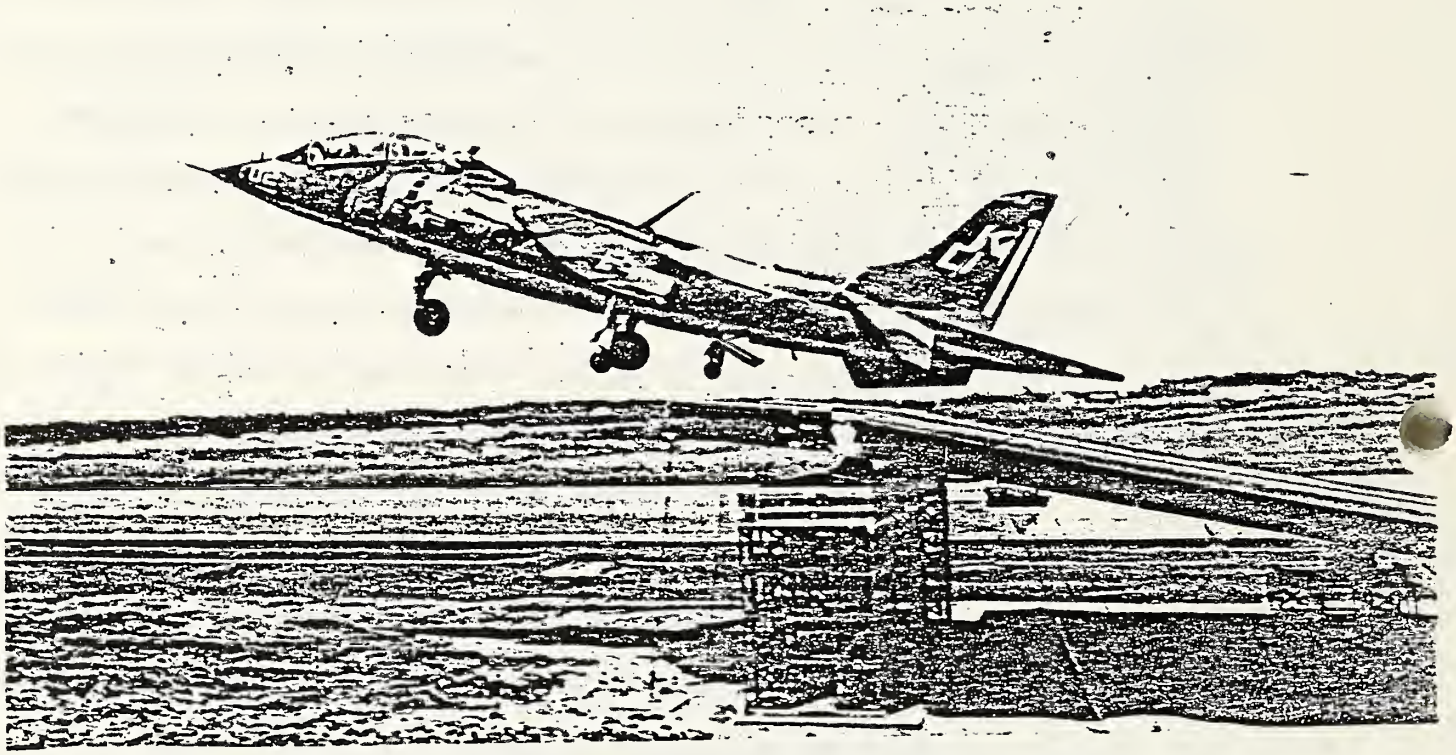
The cost comparison for the two attack aircraft was based on a 15-year life cycle and the procurement of 360 AV-8B's and 800 F/A-18's, plus the phase out costs of the attack aircraft currently in the inventory; those that the AV-8B and A-18 would replace. After looking at procurement unit costs and operational and support costs per flight hour, the study came up with a life cycle cost for the A-18 at 10-18% greater than the AV-8B. However, the larger overall F/A-18 buy combined with common siting reduced the F-18 life cycle cost about 3%. The requirement that R&D counted in the total AV-8B cost and not in the A-18 also adjusted the final numbers further (the A-18 was to be developed anyway).

In addition to costs, one of the reasons cited for reluctance on the part of the Navy to support the Marine AV-8B program was the concern that it might be forced into an AV-8B+ aircraft and smaller carrier's for V/STOL operations. The service was generally seeking to delay this.

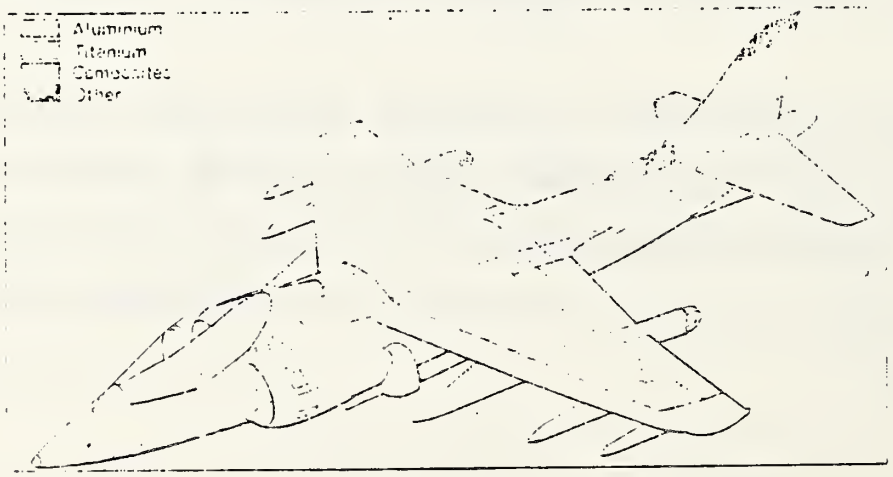
DDR&E, on the other hand, was stressing the operational utility of a V/STOL fighter in the NATO environment, where the USAF was faced with vulnerable forward locations for its airfields (which was to be covered in part by the deployment of another U.S. derivative of a European weapon, the Roland SAM system).



Source: Flight International Harrier AV-8A



Source: Aviation Week & Space Technology Harrier AV-8B



Nearly a quarter (22 3 per cent) of the AV-8B's structure is carbon-fibre composite. The material offers light weight, corrosion resistance and has no known fatigue life

Source: Flight International

The decision on whether to fund the AV-8B program in Fiscal 1979 was expected to have far reaching consequences, not only on the future of U.S. V/STOL development, but it was also one of the projects caught up in the issue of the U.S. establishing its credibility vis-a-vis the two-way-street policy with its European allies. In spite of its opposition to two of the major inter-allied programs inherited from the prior administration, President Jimmy Carter's Administration had proclaimed its continued support for the Ford Administration's two-way street policy.

Not only was the AV-8B based on a British design, but the United Kingdon was scheduled to receive work for its aerospace industry from the AV-8B program as offset for procurement of other U.S. weapons systems.

Moreover, the Marines had had AV-8A Harrier pilots in exchange billets with the Royal Air Force and soon would begin a new exchange program with British pilots taking part in Marine war games.[17]

In response to reports that the Defense Department was considering terminating the AV-8B Harrier, eight senators stepped forward in October and called for continuation of the program. The senators maintained that a decision to discontinue the AV-8B program would force the U.S. to be dependent on other nations for V/STOL aircraft until the early 1990s.[18]

"We would yield the promising V/STOL field to Great Britian and the Soviet Union," said Sen. Harrison A. Williams, Jr. (D.-N.J.).

Noting that the Advanced Harrier would be built in the U.S., Sen. Williams said: "Not only will this mean more jobs for Americans, but it will insure that we have the technology and the manufacturing capability for V/STOL aircraft in the United States."

Sen. Patrick Leahy (D.-Vt.) said it would be "highly unwise" to terminate the Advanced Harrier program. "While the Advanced harrier is currently planned as a Marine Corps aircraft," he said, "its real importance in the future will be as a naval aircraft."

Sen. Jake Garn (R.-Utah) emphasized that these could be bought "at a relatively low cost of $5.3 million per plane in Fiscal Year 1977 dollars."

Other senators who supported the Advanced Harrier program were Senators Dewey F. Bartlett (R.-Okla.), Gary Hart (D.-Colo.), Orrin G. Hatch (R.-Utah), John C. Danforth (R.-Mo.), and S. K. Hayakawa (R.-Calif.).

After Gen. Louis H. Wilson, Marine Corps Commandant, testified in favor of the AV-8B, a sympathetic Congress wound up restoring the total of $168 million.[19]

Along with a restoration of the funds came an admonition from the Senate Armed Services Committee that the program should be one of the highest priorities in the Defense Department.[20]

Although the USMC AV-8A had experienced an unusually high attrition rate (with 23 having crashed by February 1978) and despite the efforts of the Carter

Administration to keep the AV-8B from going into production, the Marine Corps and congress continued to strongly support both the AV-8A and the AV-8B programs.

b. Submittal of the FY1980 Budget: Secretary of Defense Brown Clashes with Senators Cohen and Hart. The following year, during his first budget testimony of CY1979, Defense Secretary Harold Brown once again ran into criticism from Senate Armed Services Committee as the Administration tried again to knock out the AV-8B Advanced Harrier, plus a small aircraft carrier by deleting funding for them from its FY1980 budget proposal.

Questioned about the Advanced Harrier, Brown admitted that the Marine Corps $203 million request for development was dropped out of the budget in the final month, even though "it was the highest Marine aviation priority—no question." Brown said that he made the decision because the Harrier was not one of the Navy's priorities.

Moreover, of the $123 million Congress approved in Fiscal 1979 funds to conduct research, approximately $108 million of the Fiscal 1979 funding was deferred by the Defense Department, leaving $15 million to continue testing of the two prototype V/STOL Harriers.

Senator William S. Cohen (R-Maine), took the lead this time around in questioning on the Harrier, and faulted Brown for taking a step that was contrary to the committee's action of the previous year in funding the AV-8B. Senator Gary Hart also participated in the questioning saying that the denial of funding was a "bad decision" and that he hoped the committee would reverse the decision.[21]

With the deletion of funds in the Fiscal 1980 budget for the V/STOL AV-8B development, the Marine Corps was one again faced with the prospect of having to rely totally on the F/A-18 to satisfy its needs in the late 1980s for new attack aircraft.[22]

While under questioning in Parliament several days later in late January, British Prime Minister James Callaghan said he felt assured President Carter would intervene to save the program.

c. The Deputy Defense Secretary and the Deputy CNO are sent to the Hill to Defend the Administration's Decision. In a February 6, 1979 letter to the Senate Armed Services Committee, Deputy Defense Secretary Charles W. Duncan Jr. explained that Brown made the FY '80 decision to delete AV-8B funding because of expected limitations on Marine and Navy aircraft procurement in the 1980s and the need to buy such planes in large numbers. He also indicated that, "while the AV-8B appears to have some potential for Marine Corps close air support missions, its measurable advantages over a conventional aircraft, such as the dual-mission F/A-18, appear minimal."[23]

Appearing in budget testimony before the House Armed Services procurement subcommittee later that month , Vice Adm. Frederick C. Turner, deputy chief of naval operations for air warfare, again presented the case. He said it was a long-term "affordability issue" and the coming availability of the McDonnell Douglas/Northrop F/A-18 which caused the Navy to cancel the AV-8B Advanced Harrier V/STOL aircraft.[24]

Because of "much discussion" following the cancellation he continued, "I need to comment on this . . . from two considerations. "One, the Navy has supported the AV-8B for the Marine Corps as a single-mission, close air support aircraft. The AV-8B, however, does not satisfy the Navy's more wide-ranging, multi-mission requirements.[25]

"Secondly, the cost to develop and procure the AV-8B over the next five-year period is an affordability matter of considerble significance. We calculate that the extra DOD costs and the procurement costs would be an additional $1.38 billion more than our current program which provides the F/A-18 for the Marine Corps light attack force. Thus it is the overall affordability issue, not just FY '80, and the addition of another type of aircraft that has resulted in the cancellation of the AV-8B.[26]

d. The Marine Corps Commandant Appeals to the Senate. In early March the outgoing Marine Corps commandant, Gen. Louis M. Wilson, appeared before the Congress once again, as he had the previous year, to make a final plea for what was generally perceived at that time to be a doomed AV-8B Advanced Harrier program.

He noted in testimony before the Senate Appropriations defense subcommittee that because of the deletion, the Pentagon's deferral of all but $15 million "will cause the program to slip at least another year, and could force eventual termination." During questioning, he said the Office of Secretary of Defense had informed the Marines and the Navy, that the remaining $15 million

in FY '79 money was to be used in a "Wind-down" phase, since it had been decided that the AV-8B "was not required."[27]

Wilson said this left just two YAV-8Bs flying at Patuxent Naval Test Station (Md.) and amounted to termination, if funds were not restored. He pointed out that the deferral "is costing $7.5 million a month."[28]

Wilson pulled out all the stops in praising the British-designed aircraft, built in the U.S. by McDonnell Douglas. It is not only the only V/STOL in the nation, he said, but represents "a new dimension of close air support." Not only does it have "1 1/2 times the capability of the McDonnell Douglas A-4," which it was to replace, he said, but it would be "immediately available to assist Marine landing forces and "not 100 miles away." With the British-developed "ski jump," he added, it can take off with a full load of armaments at a 15-degree angle.[29]

e. The Impoundment Control Act and Brown's Release of the Frozen FY1979 Funds. Later in March it was reported in the Aerospace Daily that, three Senate committees were considering a resolution that would block the Administration's deferral of the $108 million appropriated for FY 1979 development work on the Advanced Harrier. Sen. Gary Hart (D-Colo.), a member of the Armed Services Committee and, by this time, the leading supporter of the V/STOL program, introduced the resolution in mid-March and called the Defense Department's action in cutting the funding from $123 million "in violation of explicit congressional intent, and, in terms of the procedures chosen, also in violation of the 1974 Budget and Impoundment Control Act."[30]

Since the Pentagon in January moved to reduce the $123 million appropriated for FY '79 to only $15 million, Hart said, "no deferral notice or rescission request has been submitted to the Congress."[31]

Calling the AV-8B program "vital to the future not only of Marine Corps, but also of Navy aviation," Hart declared that the deferral "is directly contrary to the initial operational capability which the Senate Armed Services Committee specifically directed the Department of Defense to respect." Hart's resolution was referred to the Senate Appropriations, Budget and Armed Services committees. Hart also wrote a letter to the Comptroller General, Elmer B. Staats, to inform him of the "potential violation" of the Congressional Budget and Impoundment Control Act of 1974.[32]

In response, Staats wrote a letter to Vice President Walter F. Mondale, president of the Senate, confirming that a deferral had occurred and that it should be reported to Congress.[33]

As the Defense Dept. came under mounting pressure from congressional and service advocates objecting to the preference for the F/A-18 as the prime Marine Corps next light attack aircraft, Brown backed-off.[34]

Several days later, in late March, the Pentagon quietly ordered release of $108 million in the R&D money it had deferred from FY 1979 appropriations. A Hart aide said that the new DOD action had been taken "obviously because they could be compelled to release the funds."[35]

Pressure similar to Hart's reportedly was also applied by House Appropriations defense subcommittee Chairman Joseph Addabbo (D-N.Y.), who also sent Brown a letter of protest.[36]

f. The Navy Awards the Initial Full Scale Development Contract. The Navy announced on April 20 that McDonnell Douglas was receiving a $34,520,928 contract to initiate the first phase of full scale development of the AV-8B. Four AV-8Bs were to be built in the full scale development program. A spokesman for Defense Secretary Harold Brown's office emphasized, however, that this contract was not a commitment for production.[37]

Start of the phase one full scale development effort, the Navy said, opened a limited program permitting long lead components to be ordered and the engineering effort to go ahead. This would avoid a delay should a decision be made to fully develop the Advanced Harrier.[38]

The V/STOL fighter would continue to trouble Navy planners, who were concerned about handling the financial pressures of procuring several different types of combat and support aircraft in the mid-1980s.[39]

By this time, over 70 Advanced Harrier flights had been conducted with the YAV-8B prototypes. Since the first one was flown 53 days ahead of schedule, the YAV-8B had met all of its goals to date, including lifting off in vertical takeoff with a ton more than the AV-8A and lifting eight tons of useful load in a 588-foot takeoff roll.[40]

g. FY1980 Funding is Authorized by Both Houses. With the FY1979 funds restored, on May 3 the House Armed Services research and development subcommittee voted to add $180 million to the FY 1980 defense budget authorization to continue full-scale engineering development of the AV-8B.[41]

The action was a highlight of subcommittee action disclosed in a statement issued by Chairman Richard H. Ichord (D-Mo.). Ichord stressed that his subcommittee's Navy R&D recommendation "exceeded the Administration's request... by $60 million and was essential in ensuring the combat effectiveness of the Marine Corps, and represented a step toward regaining the clear naval superiority once enjoyed by the U.S. Navy but now seriously threatened by a highly effective and efficient Soviet fleet."[42]

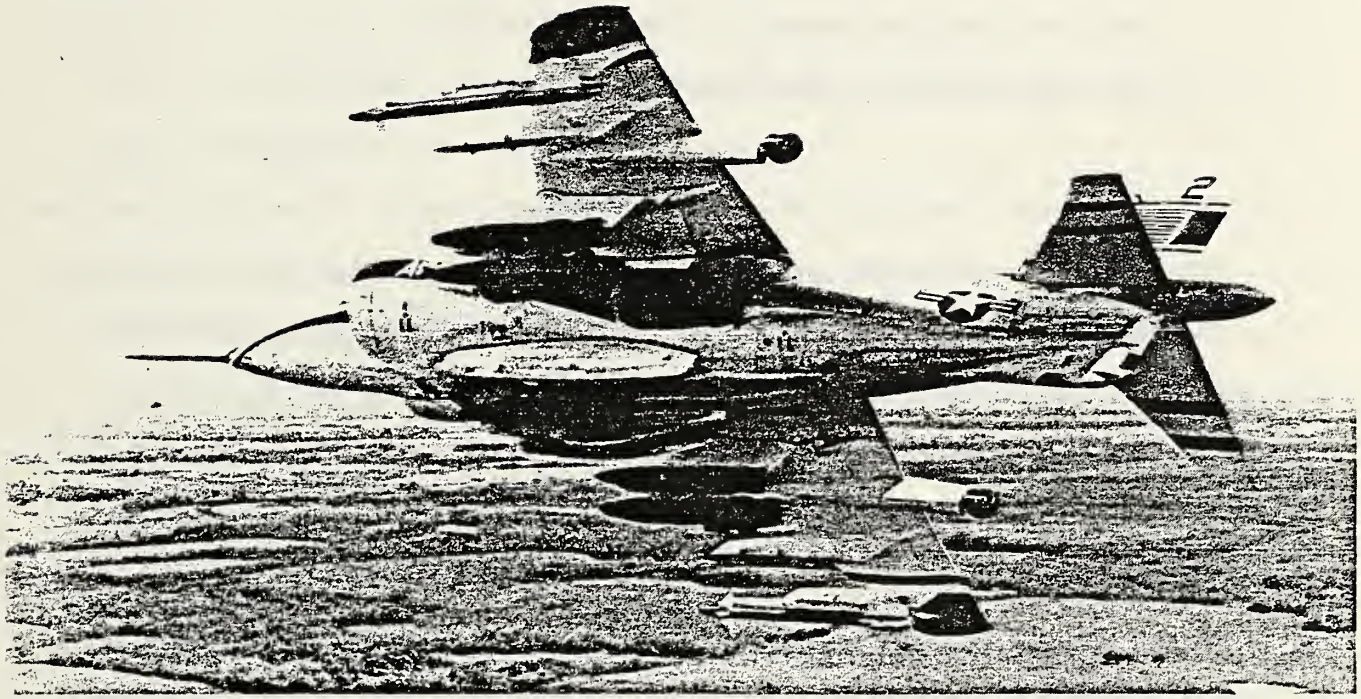
Later that month the Senate Armed Services Committee agreed with the House committee in adding the $180 million for research and development of the AV-8B.

With the procurement funds added to the FY '80 budget by Congress the first production Advanced Harriers were expected to be available in 1984, with the first squadron of 20 AV-8Bs fully operational by 1986.

h. The Marine Corps Makes Its Case. The Marine Corp's Advanced Harrier program manager, Col. S. P. Lewis, in an interview with Aerospace Daily, on June 6, 1979 ticked off a series of reasons why he was more confident than in the previous year's budget drills that the AV-8B would be permitted by Pentagon brass to go into production:

- The technical success of the flight test program.

- Continued suport of Gen. Louis H. Wilson, Marine commandant, who kept saying the Corps "must have" the AV-8B even after it was zeroed by the Office of the Secretary of Defense in preparing the fiscal 1980 budget last fall.



Marine Corps/McDonnell Douglas AV-8B Advanced Harrier is armed with five 500-lb. bombs—two on each wing pylon and one on the centerline station—and with two AIM-9 Sidewinder infrared-guided missiles. This is the second prototype aircraft flying from Patuxent River, Md., after a vertical takeoff test to meet its weight specifications. Note the two empty pylons.

- The steadfast support in Congress with the increasing likelihood that for the second straight year it will add Advanced Harrier funds to the budget.

- The need to take the next step in the Corps' evolution, charted in the 1950s, toward the mobility of an all-V/STOL air force.

- The confidence that in this fuel-conscious period Pentagon officials will seek the long-term economy in the single-engine AV-8B with its high by-pass ratio turbofan and minus afterburners.[43]

Yet at the same time, the AV-8B project manager, was still unable to say that OSD would reverse itself on the almost $6 billion question and set the stage for McDonnell Douglas production of the proposed 336 Advanced Harriers.[44]

The Advanced Harrier was scheduled to go before the Defense Systems Acquisition Review Council for clearance of milestone two, full-scale engineering development, in July.

Lewis said the opposition to the Advanced Harrier stressed the initial substantial investment needed to develop the AV-8B as compared to a smaller outlay for a comparable number of McDonnell/Northrop F/A-18s for the light attack and close air support role. Cost didn't become the critical factor if the comparison is put in terms of life cycle rather than acquisition price tags, he added.[45]

Only the Advanced Harrier, he continued, would give the Marines the needed ability to operate in austere environment and without the world-wide bases the U.S. once had.

The AV-8B, "is not the end of the line but another significant milepost" in the course the Marine Corps charted for itself in the late 1950s leading to an all-V/STOL force.[46]

Similar to helicopter development in an earlier period, the AV-8B is part of a similar progression, he said.

Unless you follow the progression--technically, tactically and doctrinally--you never get there. Those who look for quantum jumps when the AV-8B has more than doubled the performance of its predecessor, they're in error. If you don't do something now, I would say V/STOL will probably be in serious trouble in the United States until the end of the century.[47]

In July, appearing before a Congressional hearing, the new Marine Corps commandant, General Barrow, called the $6 billion AV-8B Advanced Harrier V/STOL a "difficult...burden" for the Marines without other service or foreign customers.[48]

He felt that other customers would help overcome OSD resistance to the 336 aircraft program. "It's difficult for a service our size to bear the burden of something like that," Barrow said. The Corps never had the expectation when it went into the Advanced Harrier program that it would be the only buyer,

he added. The Marines, he said, thought they would be introducing the V/STOL aircraft and then others would jump in.[49]

Barrow denied that the lack of customers was due to the Advanced Harrier's performance. He said the AV-8B is living up to expectations and represented an "enormous step forward" for V/STOL development.[50]

He said there have been "well over 100" ski-jump takeoffs with no incidents, permitting a reduction in the roll by over 50%. The British ski-jump off a 16 degree slope permits a 28,000 pound Harrier payload to use a 450 foot runway instead of 1000 feet.[51]

i. The Industrial Partners Continue to Explore Options. Later that year, in the fall of 1979, McDonnell Douglas and British Aerospace exchanged Senior Technical Teams. The British team reviewed development of the McDonnell Douglas AV-8B, and the McDonnell Douglas team looked at British work with the proposed Harrier Mk. 5, which was still being considered by the Royal Air Force for retrofit to its existing Harrier force.

The two companies held talks on the joint development of advanced VTOL combat aircraft, which had been given impetus by indications that there was increased interest within NATO in VTOL aircraft for use from forward areas.[52]

The Mk. 5 version of the Harrier was designed to meet Royal Air Force requirements for agility in a low-level strike/interdiction role.

Marketing programs under consideration, pending the findings of technical teams, involved the following possibilities:

- Modification of the existing Hawker Siddeley AV-8A and AV-8C aircraft in the U.S. Marine Corps inventory into the Mk. 5 version, in order to increase the capability of the aircraft and prolong their life.

- Modification of the existing Harrier Mk. 1, Mk. 1A and Mk. 3 versions now in service with the Royal Air Force into Mk. 5 versions.

- Exploration of the possibilities of coproduction of the AV-8B for use by both the U.S. Marine Corps and the Royal Air Force.[53]

j. YAV-8B Prototype No. 2 Crashes. In mid-November one of the two YAV-8B Advanced Harriers crashed in Missouri.. Though untimely it was to have little effect on the full scale development program, just then getting underway. Unfortunately, the second prototype was the most representative aircraft. It would take some time to modify YAV-8B No 1, which was used mainly for vertical and short take-off trials, to the later standard.

The aircraft, flown by McDonnell Douglas test pilot experienced an engine "malfunction" while cruising at 40,000 feet enroute to Whiteman AFB, Mo., for refueling. After five minutes of trying to regain full thrust, the pilot ejected at 10,000-12,000 feet.[54]

The McDonnell spokesman said, "We expect no change" in the full scale development program, which involves testing of four AV-8Bs, now being built.[55]

In spite of this crash, with the successful completion of initial sea trails in October, the YAV-8B Advanced V/STOL aircraft achieved all performance objectives in its 1979 flight demonstration program.[56]

k. FY1981: Brown Again Recommends Termination. For the third year in a row, however, the Carter Administration would not step forward to support the AV-8B program.

In January 1980, when probed on this subject, Defense Secretary Harold Brown declined to comment on the status of the AV-8B Advanced Harrier in the 1981 defense budget. He only indicated that he remained skeptical of purchasing the McDonnell Douglas V/STOL aircraft for the US Marine Corps. "I think the AV-8B is a good thing to have around. But the question is, is it worth paying the extra price and the price in reduced total numbers of aircraft...in order to get the VTOL capability. There is a division in opinion within the DoD on this."[57]

For the AV-8B to enter Marine Corps service in 1985, money for pilot production of 12 aircraft had to be provided in the FY 1981 budget. As in the two previous years Congress again took the initiative in providing the funding for the AV-8B project.

l. The British Question. Other customers for the AV-8B were being sought to increase orders and ensure production. Britain in particular, had been approached in an effort to get the Royal Air Force to buy the American AV-8B to replace their MK.1 and MK.3 Harriers. Britain would require about 60 aircraft initially, with a further 40 in the long run.[58]

The British Government was expected to have made some response to the U.S. initiative by the end of 1979, but Prime Minister Margaret Thatcher made only "a passing mention" of the AV-8B on her visit to the US, during this period. Again, British industry was to have a significant role in any eventual AV-8B production, not just the prototype, engineering development and pilot production aircraft. British Aerospace would build the center and aft fuselage sections, Rolls-Royce would provide the Pegasus 11 engine, Dowty the undercarriage, Smiths the HUD, Dunlop the brakes, and Lucas the generator.[59]

The crash of YAV-8B prototype No 2 did not seriously impact the USMC program, as previously mentioned, but its loss on the eve of an RAF evaluation appeared to have delayed the British reply.[60]

m. FY1982: The AV-8B Project Finally Reaches Firm Ground. Until the final months of the Carter Administration, the AV-8B had been funded at the insistence of Congress. As of the summer of 1980, the AV-8B wasn't in the Pentagon's FY 1982 budget plan. Leaving office in January, the Carter Administation did submit budget proposals, however, for FY 1982 that included its first recommendation that AV-8B development continue to be funded, at $230.7 million. Production, however, was still excluded. The Reagan Administration several months later added $657 million to procure the first pilot production planes (12) and thereby maintained an IOC of 1985.[61]

The mixed force of F/A-18s and Harriers continued to haunt the Navy, though. Speaking in a closed session on the F/A-18 production rate and cost problems on Sept. 24, 1981, Adm. Thomas B. Hayward, Chief of Naval Operations, told a

Congressional subcommittee that the Navy was "driven to this very low rate buildup (66 F/A-18s) because we have to absorb the AV-8B procurement. "I have always been for the AV-8B, "Hayward told the hearing, "but the price we pay is that it increases the unit cost of the F-18, and we are stuck with that."[62]

5. An AV-8B+ for the U.S.N.?

As a subset of the debate over the AV-8B for the Marines, the issue of an AV-8B+ variant for the U.S.N. had simmered on.

The top-level Navy position, which had been expressed in budget testimony by Secretary W. Graham Claytor and Chief of Naval Operations Adm. Thomas B. Hayward in early 1979, had been that it will be "at least 10-15 years" before the V/STOL program develops a plane adequate to the Navy's needs in the fighter role.

An Executive summary of a Naval Air Systems Command study, was placed in the Congressional Record in March, 1979 by Sen. Gary Hart (D-Colo.), a member of the Senate Armed Services Committee, which concluded that the McDonnel Douglas AV-8B+ Advanced Harrier "is capable of providing a variety of missions for the U.S. Navy . . . while operating from small air-capable ships either as an element of an independent V/STOL task force or as part of a conventional carrier task force" and could be available by 1985. It was obtained by the Senator apparently even though, according to one congressional source, "certain admirals hadn't approved it."[63]

Hart, who had become the leading congressional champion of the V/STOL carrier concept, declared in remarks accompanying the insertion that the study "shows

that the Navy can have V/STOL aircraft in service by 1985, at least 10 years sooner than previously predicted."[64]

He observed that until now the Navy had said that the AV-8B+ "would not be mission-capable, and that adequate V/STOL aircraft could not enter service until around 1997. This change of view . . . means that we can and should begin now to build small aircraft carriers for V/STOL aircraft—not the 60,000-ton carrier requested by the Administration, but 25,000-ton carriers which we can afford in larger numbers."[65]

Hart said the Navair findings "open a new door for the Navy . . . leading toward a more flexible, more survivable fleet in the 1980s. I hope my colleagues will join me again this year in ensuring that the door stays open— that we continue the AV-8B program and its naval derivative, the AV-8B+."[66]

The Naval Air Systems Command study said the McDonnell Douglas AV-8B+ "provides the Navy with its only near-term V/STOL tactical aircraft option" and "when introduced . . . can give an immediate tactical air capability on 87 ships plus a potential use on another 174 ships, including about 100 Merchant Marine Container ships."[67]

The report said the "plus" variant of the Marine Corps' AV-8B light-attack, vectored-thrust V/STOL is "currently being validated" by flight demonstrations with the YAV-8B prototypes which have shown that it "is capable of performing a variety of missions for the U.S. Navy, including anti-ship, air defense, land strike, cooperative anti-submarine warfare and surveillance." The report continued,

> The AV-8B can meet the mission requirements while operating from small air-capable ships either as an element of an independent V/STOL task force or as part of a conventional carrier task force. The aircraft incorporates mission-enhancing features including an inertial navigation system, a multi-mission radar, Navy avionics suite, full autopilot, increased electrical power and expanded weapons capability.
>
> The AV-8B has greater combat effectiveness than any other tactical aircraft, conventional or V/STOL, for its size and weight class. It has a more precise weapons delivery system, carries a greater weapons load, has better flying qualities, increased performance, improved cockpit, reduced pilot workload, and improved flight safety compared to (the AV-8A) . . . technology advances, along with the utilization of weight-saving composite materials essentially double the mission-performance capability of the AV-8B compared to the AV-8A using the Navy mission ground rules....(AV-8B+) for close-in air-to-air combat ....with thrust vectoring is highly maneuverable and combat-capable. The pilot has a choice of air-to-air missiles or guns for air combat. He has the choice of returning to his primary sea base or recovering on a nearby platform of some small or alternative air-capable ship for immediate refueling and rearming if necessary. He could then be combat-ready, loaded for a follow-on directed air defense type mission. Finally, the AV-8B+ has the capability to conduct air intercepts from a variety of air-capable ships while in port, dockside or at an anchorage.[68]

In late October of that year, while appropriating the $180 million authorized in FY 1980 for the AV-8B, the Senate Appropriations Committee then went a step further and made an additional increase of $5 million for R&D on the AV-8B+.

6. Britain's Big Wing Harrier Mk.5 Development Program.

In the same year that the joint program with the U.S. was cancelled and the Sea Harrier project was launched, 1975, Hawker Siddeley (Kingston) was awarded a research contract to design a new wing for an advanced Harrier. The aim was high subsonic performance with good maneuvering capability, together with a relatively thick wing section to provide increased internal fuel capacity compared with the existing Harrier.

In late 1976, discussions took place between the Ministry of Defence and BAe (Kingston) over the possibility of rewinging the entire RAF Harrier fleet.

While the original aircraft was recognized as effective in its primary roles of ground attack and reconnaissance, its self-defense capability was considered limited by lack of air-to-air weapons and a relatively high wing loading. The aims of the development were to retrofit existing aircraft with the so-called Big Wing, but with minimal alterations to fuselage or other structure; to provide a marked increase in maneuver capability; to accommodate two extra pylons for missile carriage for AIM-9L Sidewinders to provide an air-defense capability; to improve STO performance over that of the existing aircraft even when carrying additional missiles; to decrease present outrigger track for operations from narrow roads; and to increase internal fuelcapacity, if possible, removing the need for external fuel tanks on certain sorties.[69]

Preliminary feasibility studies for providing a new, larger wing on the Harrier were completed in early 1979. The project was viewed as allowing the U.K. to continue V/STOL development into the foreseeable future and would ensure that the RAF had a V/STOL ground-attack/reconnaissance capability through to the mid-1990s.[70]

It was found that the performance of the basic wing section designed under the research contract was suitable for this new application and so this, together with an input from another research program—investigation into the effects of wing leading-edge strakes (LERX—Leading-Edge Root eXtension) formed the basis for the full wing design.[71]

To achieve the performance improvements and to accommodate the extra wing pylons, area was increased by 25% over that of the earlier wing, and the span by 27%.

With a much thicker cross-section than the earlier wing (because such thick structure can be built lighter per unit area and for a given strength) the structural weight penalty of the bigger wing was reduced and internal fuel capacity increased by 245 gal.[72]

Much as with the F-18 and the AV-8B in the U.S., the future of the Harrier in Britain had been embroiled for several years in the discussions over a standardization on a multi-mission aircraft, Air Staff Target 403 for a Jaguar and Harrier replacement, and the question of British/German/French collaborative development of a new combat aircraft for the 1990s. But in early 1979 the RAF began the process of separating the Harrier replacement program from AST 403, which resulted in two Air Staff Targets, one for a high-performance interceptor/attack aircraft (which still might be collaboratively developed) and the other for long-term Harrier modernisation on a national basis designated the Harrier Mk.5, AST 409.[73] AST 409 called for an advanced V/STOL combat aircraft to supplement the existing Harrier GR3 force.

The interceptor/attack aircraft, AST 403, in the view of some top RAF officers, should also have V/STOL capability. A reason for the "weight of opinion" in this direction, centered on concern over the relative vulnerability of NATO's fixed bases to Soviet air and missile attack. A V/STOL aircraft need not operate from such sites.[74]

The RAF felt that the new wing would be better suited than that of the U.S.M.C. AV-8B for air-to-air combat. The RAF explained that the AV-8B Harrier wing wasn't a supercritical airfoil, and therefore load distribution over its upper

surface was relatively uniform, instead of dropping off toward the trailing edge as is typical of a conventional airfoil. With BAe's supercritical wing, however, the aft fuselage would have to be strengthened to match the G forces the wing can take in hard maneuvering. The two prototype YAV-8Bs under test by the U.S. Navy and Marine Corps themselves lacked rear fuselage strengthening and as a result had a stress level of 5.5 to 6 Gs. A production AV-8B was to have a beefed up fuselage, so as to be able to take 7 Gs.[75]

In any event, strengthening fuselages on the RAF Harriers was considered to be expensive. Besides retrofitting Harriers now in service, the RAF was planning to put the new wing—and apparently other improvements, as well—on 60 to 100 additional Harriers that would be bought to offset attrition and to maintain combat strength. Sources would not comment on how much this might cost, but they did say that "compared to building a new aircraft, it's small."[76]

But the issue didn't end here. The RAF proceeded with its evaluation of the two YAV-8Bs (suspended for several months in late 1979 and early 1980 after the loss of one of them) which was to be completed in mid-1980.

In December 1979, under questioning in the House of Commons on the Harrier choice, British Under-Secretary for the RAF Geoffrey Pattie told the Parliament that the U.K.'s share of work on the the U.S. Marine Corps AV-8B Harrier would amount to 30 percent of the airframe and 75 percent of the engine. Some 16 U.K. companies were involved in the project and would have a share of work if the Marine Corps went ahead with the aircraft.

He also said it would be a "matter of judgement" whether data from Advanced Harrier flight tests so far completed would be sufficient for the RAF to make an evaluation of the aircraft. Although the second AV-8B prototype had recently crashed, Mr. Pattie said that study of data from flights with the first aircraft and whatever had been gained from the second was proceeding.

"The longer term interests of the Harrier program must lie with the possible development of a supersonic Harrier capability," he told the Commons. "It must be an open question whether we would wish to develop that capability whatever the outcome of the much shorter term decision on the Mk.5 system."[77]

The U.K. faced difficult alternatives:

1) to go for the Harrier Mk 5 and maintain British V/STOL design potential embodied in the team at British Aerospace Kingston, or;
2) share in a much larger AV-8B program and relinquish further thoughts of design leadership.

On the latter point though, the RAF still had bitter memories of John Kennedy's breach of faith when the Skybolt stand-off missile which was being developed in the early 60s in the U.S. for both the USAF and the British Medium Bomber Force, was unilaterally cancelled. This experience was still expected to color a decision on the AV-8B alternative.[78]

To meet AST 409, it was felt the AV-8B wing would have to be reprofiled to nearer that of the Harrier Mk.5, which had a better manoeuvre capability

essential for operations in Europe. Prices of the Harrier Mk.5 and the AV-8B were understood to be very similar, with the British claiming a slight edge for the former.[79]

On the other hand, for production, a USMC AV-8B deal would offer BAe a larger share, which would be on all aircraft built. All parts would be single-sourced but there would be two assembly and test lines, one in the U.S. and one in the U.K. In addition, Rolls-Royce would benefit from over two-thirds of the production of all Pegasus engines installed in the U.S. aircraft and all of the engines in the RAF versions. An RAF order for Harrier Mk 5s would be for 60-100 aircraft, while USMC orders for AV-8Bs would be around 340.[80]

A sine qua non of the second option involved the U.S. getting its ducks lined up. The conflict between the USN/DoD and USMC/Congress over the AV-8B was 2-1/2 years old as of mid-1979, as the debate went on over the two alternatives in the U.K. The Economist published an editorial on the subject in its June 2 issue entitled, "The Tinwing Temptation: Don't. Go Anglo-American Instead, and Save Big Money!"

> A new government, lifting its eyes to the great problems ahead, should not omit to notice the small opportunities for doing itself a bit of good that lie under its feet. Here is one such opportunity for Mrs. Thatcher's government in the field of defence.
>
> In the past couple of years, a new mood of cooperation has taken shape within the NATO alliance. The idea of collaboration in arms production—the notion that countries can save billions of pounds of duplicated research and development costs by building weapons together rather than separately—has suddenly got everybody nodding approvingly. Britain can apply this new conventional wisdom to a decision it has to take soon in the matter of the Harrier attack aircraft.

The Harrier . . . was a major British technological achievement. Its main military drawback is the fact that its range, when loaded, is inconveniently short. But today's technology can double the Harrier's range (or its payload) by means, mainly, of a new sort of wing. The Americans have built a prototype of an advanced Harrier, called the AV-8B, with a wing made of lightweight composite material instead of metal. The American Marine Corps hopes to buy more than 300 of these aircraft, and Britain would get about half the work in making them. Snag, the American defence secretary, Mr. Harold Brown, wants the marines to have a conventional fighter-bomber instead.

The RAF also needs to expand and improve its Harrier force for service in the 1980s and 1990s. The American AV-8B prototype is still mostly the British Harrier, and British industry is still tooled up to make most of it except the composite wing; much of the development work on the wing and the other modifications is already paid for. The new aircraft seems a natural for Anglo-American collaboration. However, the RAF is thinking of designing another new wing and building an advanced Harrier of its own. This British new wing would be made of aluminum instead of composite, which has got the new aeroplane called the "tinwing Harrier."

There is one small advantage, one big drawback and one enormous gamble in Britain's going it alone with the tinwing machine. The advantage is that the new British wing could be designed to fit on the RAF's existing Harriers; the composite one, designed by McDonnell Douglas, won't. Thus the RAF could have a fleet of identical Harriers by re-winging the old ones with the aluminum wing and building its new ones with it. Their performance would be less good than the AV-8Bs, but this would be the least of the problems.

The drawback is that designing and building yet another wing is expensive. A new tinwing Harrier, including the development money, would cost more than an AV-8B; and, because the Americans would pay almost all the AV-8B development costs, it is entirely possible that the combination of new tinwings and refits could cost Britain more than an entire fleet of new AV-8Bs built in collaboration with the United States.

But the main trouble with the British only solution is the gamble that the United States will cancel the AV-8B project if nothing happens to change Mr. Harold Brown's mind. If Britain were to join in the AV-8B programme, this would almost certainly make it safe from cancellation. . . . . The idea of arms co-production is to get more defence for our money in a time of inflation. There has seldom been such a clear cut example of the benefits of collaboration. The Thatcher government should ask the United States to continue with the AV-8B and offer to take part.[81]

In mid-1980, engineers from Rolls Royce visited the U.S. to discuss the next step in development of the Harrier V/STOL concept--supersonic flight.

But, before any decisions were to be made on a supersonic Harrier, in the short term, some hard choices still had to be made on subsonic ones, first the final shape of a Marine Corps' order for an A-4 and the AV-8A replacement, and then the U.K.s own decision on a replacement for the first generation Harrier.

7. Series Production of the AV-8B for the U.S.M.C. is approved.

After three and a half years of congressional and U.S. Marine Corps persistence in attempting to overcome the Carter Administration's reluctance to fund the AV-8B, the project finally got a green light on the U.S. side of the Atlantic in early 1981 from the Reagan Administration for a 336 aircraft production run.

This support was sustained in spite of the fact that the AV-8A continued to have highest average annual accident rate of any aircraft in the active Navy and Marine Corps inventory. Modification on the AV-8B Rolls Royce engine and its new Sperry flight control system were expected to produce a considerably safer aircraft.

The U.S. Marine Corps program was to cost an estimated $9.1 billion. The first of 12 pilot-production Harrier IIs were to be delivered to the Marine Corps in October 1983, and the first of eight V/STOL light-attack squadrons will be operational in June 1985. Initially, the AV-8B will re-equip the three squadrons now using AV-8A Harriers purchased from the U.K. in the early 1970s. The last

The advantages of V/STOL advanced.

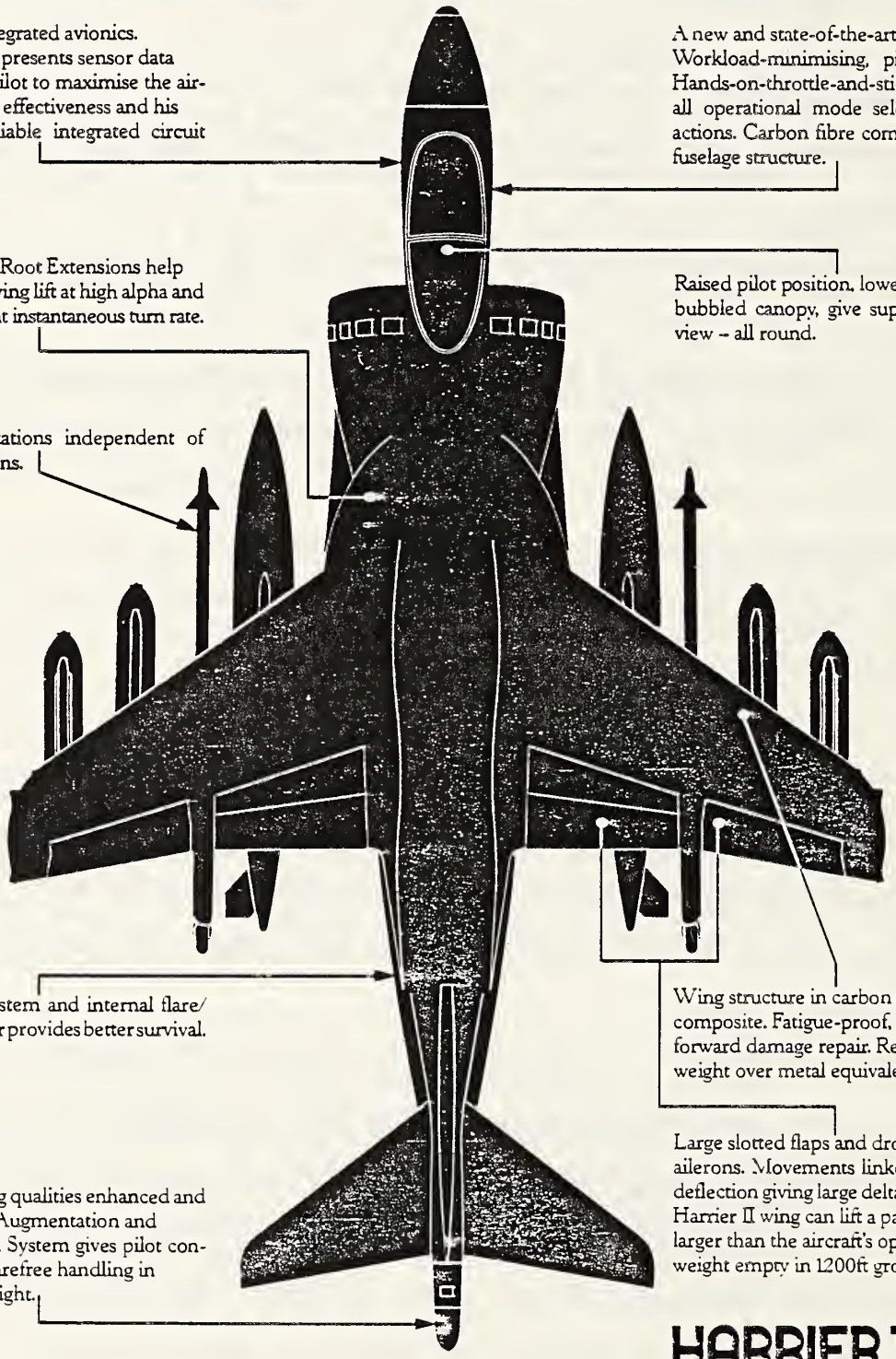
All-digital, integrated avionics. Processes and presents sensor data allowing the pilot to maximise the aircraft's mission effectiveness and his flexibility. Reliable integrated circuit avionics.

A new and state-of-the-art cockpit. Workload-minimising, pilot-friendly. Hands-on-throttle-and-stick provide all operational mode selections and actions. Carbon fibre composite front fuselage structure.

Leading Edge Root Extensions help extract more wing lift at high alpha and greatly augment instantaneous turn rate.

Raised pilot position, lowered sills, bubbled canopy, give superb combat view – all round.

Sidewinder stations independent of ordnance pylons.



New ECM system and internal flare/chaff dispenser provides better survival.

Wing structure in carbon fibre composite. Fatigue-proof, fast straightforward damage repair. Reduced weight over metal equivalent.

Large slotted flaps and droopable ailerons. Movements linked to nozzle deflection giving large delta lift in STO. Harrier II wing can lift a payload 120% larger than the aircraft's operating weight empty in 1200ft ground roll.

V/STOL flying qualities enhanced and new Stability Augmentation and Attitude Hold System gives pilot confidence and carefree handling in powered lift flight.

HARRIER II

FROM THE BRITISH AEROSPACE AND McDONNELL DOUGLAS TEAM
100 PALL MALL, LONDON.

HARRIER II. UK DESIGNATION GR MK5. ENTERING THE RAF IN 1987. FURTHER ADVANTAGING AN UNMATCHED HARRIER FIELD FORCE.

of five McDonnell Douglas A-4M Skyhawk squadrons will transition to the AV-8B in 1989.[82] The U.S.M.C. will have an all AV-8B attack force by the end of the 1980s.

Meanwhile, the first two of the four FSD aircraft flew prior to the end of 1981 (October and December).[83]

Actually, initial requirements were 257 for the USMC. The longer-term Marine Corps requirement is for up to 336 AV-8Bs. To support the AV-8B training requirement the Marine Corps may also require in the mid 1980s, a further 18 two-seat TAV-8B.[84]

8. The British Ultimately Opt for the AV-8B.

The British Ministry of Defense and the main industrial partners in the program announced the UK's decision to go with the AV-8B on August 24, 1981. The Royal Air Force purchase of two development and 60 production AV-8Bs was expected to be worth about $1.4 billion. The RAF will receive two development aircraft from the early U.S. production run, and delivery of an initial 60 production Harrier GR 5s off the BAe line will begin in 1986.[85]

This brought total requirements to 400 or more aircraft.

Two FSD aircraft will be used for weapons system certification flying, plus—since most of the RAF's Mk.5s are expected to be based in the FRG—a fatigue test airframe to clear the aircraft for the rigorous Central European low-level operating environment.

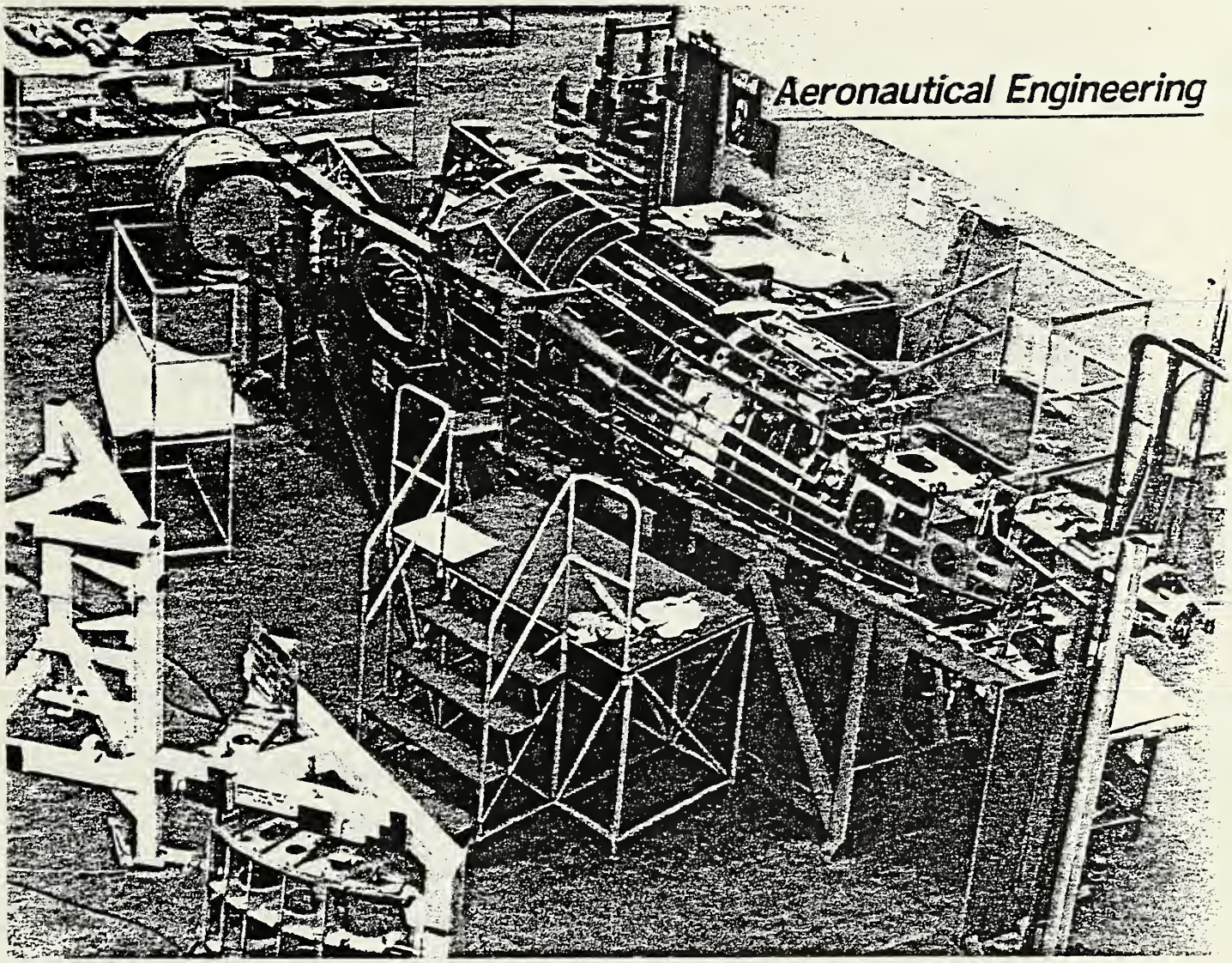
As most of the RAF AV-8Bs will equip ground-attack units based in the FRG, Harrier GR.5 wartime missions will include deep penetration of Soviet-held territory. As a result, RAF aircraft might differ slightly from Marine Corps close-support Harrier IIs, although the two Services were working to harmonize requirements and to produce a common aircraft.[86]

Changes envisaged for RAF AV-8Bs include a cockpit-projected map display, Martin-Baker ejection seat, nose-mounted strike camera, a U.K. electronic counter-measure (ECM) system, increased birdstrike protection, and wing leading-edge root extensions (LERX) to improve maneuverability.[87]

The moving map, based on the front-cockpit repeater display installed in strike MRCA Tornadoes, were to be offered to the Marine Corps, and there was a strong feeling that the system could be adopted.[88]

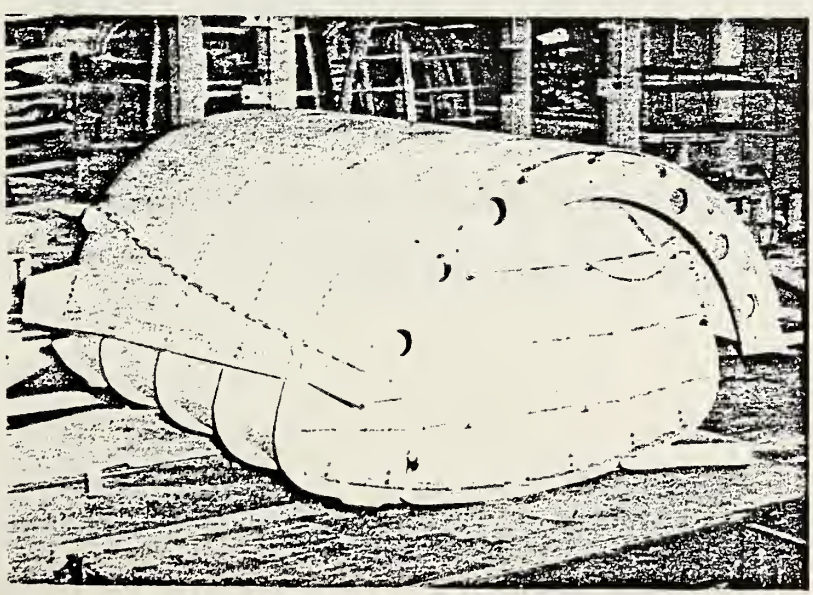
The Marines had indicated that they may fit the leading-edge root extensions (Lerx) developed by BAe to help meet RAF pitch response requirements. The addition of British LERX to the McDonnell Douglas wing will add another four degrees per second to the AV-8B's turn rate, enabling it to meet the RAF's requirement for about 20^{o}/s and enhancing still further its air combat capability for for the American service. Although the Lerx increased instantaneous turn rate, for the U.S.M.C., it was thought that the Lerx would degrade sustained turn rate, an important Marine corps requirement.[89]

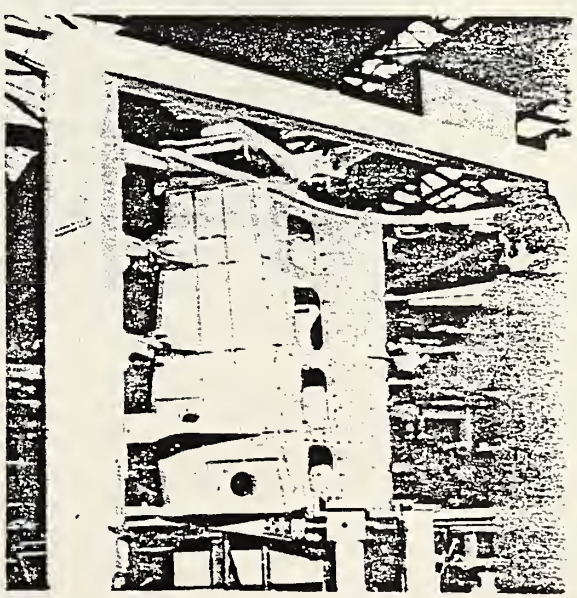
Both USMC and RAF Harrier IIs will share the Hughes Angle Rate Bombing System (ARBS). After a poor-weather evaluation of the ARBS installed in an A-4M, the



British Producing AV-8B Components

First six AV-8B fuselage sections are under construction at the British Aerospace factory at Kingston-upon-Thames. First fuselage section will be shipped to McDonnell Douglas in St. Louis early in 1981 and the first of four flying full-scale development aircraft is scheduled to make its first flight in October, 1981. The other two aircraft will be used for fatigue and static tests. British Aerospace will manufacture the center and rear fuselage sections of the AV-8B if the aircraft is ordered into quantity production. Structural and systems mockup of the aft fuselage (above) shows the portion being built by British Aerospace. The mockup is being used to fit subsystems and ducting into the airframe. Rear fuel tank (below left) for the AV-8B shows machined endplates and one-piece formed top skin. Design requires little use of tank sealant and subsequent improvements in both weight and fuel leakage. Worker at Kingston assembles one of two forward fuel tanks carried in the AV-8B (below right). The tank fits on the starboard side of the aircraft.





RAF decided that the TV/laser-spot tracking system is suitable for weapon-aiming in European weather conditions. The first generation Harrier's are armed with two 30mm Aden cannon, but it seemed likely that both USMC and RAF AV-8Bs will use the General Electric GAU-12 25mm rotary cannon, with the gun in one underfuselage pod and ammunition in another.[90]

9. The AV-8B Harrier Industrial Partnership.

The 60:40 industrial cooperation split agreed to by McDonnell Douglas and British Aerospace establishes two final assembly lines; one at St. Louis for 340 USMC aircraft and 75 percent of third-country sales; and one in Surrey starting up several years later for the 60 RAF aircraft and 25 percent of export orders. Production rates will be 4-1/2 and two per month, respectively. All Pegasus engines will be assembled by Rolls-Royce, with Pratt & Whitney as a subcontractor.[91]

A joint marketing team is to be formed, and geographic areas of responsibility will be assigned to the two partners. The forecast market potential of 800 to 1,000 aircraft includes 300 to 400 outside the U.S. Services. McDonnell Douglas anticipates developing a radar-equipped AV-8B derivative early in the program for the U.S. Navy and for export customers requiring a multirole land-based or sea-based aircraft. McDonnell Douglas believes that the U.S. Navy could order basic AV-8Bs by the mid-80's.[92]

AV-8B development potential includes engine thrust increases of between 1,500 lbs and 3,000 lbs depending on the level of funding.

Speaking at the rollout ceremony, Eric Rubython, deputy chief executive, BAe Aircraft Group, noted the "mutual trust" between the two companies, while Sanford McDonnell, McDonnell Douglas chairman and chief executive, described the AV-8B as a triumph of common defense and international cooperation. Gen. Paul Kelley, assistant commandant of the Marine Corps, said that the AV-8B unique capabilities "may be the margin between victory and defeat for the infantry commander.""[93]

The industrial partnership has also been expanded to include the U.S.N.'s T-45 version of the BAe Hawk trainer/ground support fighter, to be built in the U.S. by McDonnell Douglas under similar licensing and work sharing arrangements.

10. A Supersonic V/STOL Fighter?

McDonnell Douglas and British Aerospace have shown interest in continuing their V/STOL collaboration beyond the AV-8B, although neither has committed in writing to anything further than discussions on future cooperation as of the fall of 1981. Both partners have shown interest in supersonic V/STOL development. An AV-8SX Mach 1.6 demonstrator could be flying within 33 months of go-ahead, Rolls-Royce believes, based on a stretched AV-8A airframe with supersonic aerofoil and intake, and a Plenum-Chamber Burning Pegasus.

The idea of making such an aircraft supersonic was not new. As touched on briefly earlier in the subchapter, Rolls Royce had been working on development of a supersonic powerplant for the P.1127 Kestrel design in the early and mid-1960s. Though that project was subsequently cancelled, a Ministry of Defence contract in 1979 for further testing of a supersonic V/STOL capability revived it.

The engine in question remains the standard Pegasus powerplant familiar in all Harrier variants. To make it provide supersonic power, Rolls Royce has been proposing a system known as Plenum Chamber Burning, or PCB.[94] This, essentially, is a method of burning a fuel spray in the aircraft's front nozzles in much the same way that augmented thrust is obtained from an afterburner fitted to a conventional aircraft.[95] The renewed interest from the Ministry of Defense apparently came from a desire by the Royal Navy to look at supersonic power options for the new Sea Harrier. Moreover, the USAF had also recently shown some interest in the concept.

The Rolls Royce team regards the U.S. as a potentially important market for the PCB concept. Quoting from a document issued by Rolls Royce, "USAF is concerned that that the bases it operates from in the NATO support role may be pretargeted and immediately vulnerable to enemy attack," the document continues. "USAF wants a V/STOL capability to insure against destruction of runways, and allow dispersal to other fields."[96]

The company also believes that the U.S. Navy will ultimately decide to complement existing nuclear powered aircraft carriers with smaller air-capable ships. One alternative V/STOL type needed for this application will be a supersonic fighter-attack aircraft."[97]

11. Concluding Remarks.

The successive Harrier projects, much like most inter-allied projects, have had a highly visible and controversial history. An advanced version of the system is now entering production in the U.S. after a long history of ups and

downs, and at best low-level support from within the DoD (at least up until recently), where VTOL fighters have long been viewed as a marginal requirement. The uneven history of interest by the DoD in the system now covers a quarter of a century and has involved two other inter-allied off-shoots (both resulting in dead ends for the USAF): the NATO Basic Military Requirement No. 3 in the 1960-62 timeframe; and the AVS project with the FRG between 1964 and 1968.

Worthy of note is the instrumental role the Harrier project has played in creating one of the most formidable industrial fighter aircraft teams, with its recent expansion to include the U.S. Navy's T-45 trainer. It can be expected that the McDonnell Douglas-BAe team will be a long-term force in the world fighter market; including future VTOL fighters among others.

Now, why the detailed coverage in this sub-chapter of the contest between Congress and the DoD under the Carter Administration over the military requirement represented by this unique system? Controversy surrounding a military requirement or system is by no means unique in this business. It does seem to be endemic, however, for those systems that are not the direct off-spring of one of the U.S. services. The U.S. services are generally able to enjoy the option of spawning virtually all of their own, perogatives open only to a superpower with all the ensuing funding and technological options. This explains much of the difficulty involved in mating foreign systems to U.S. military needs. Even when there is a temporary opening, its an up hill battle, as we've seen with several other of the programs covered in this chapter.

These foreign systems were originally tailored to military requirements that have been given a lower priority by the U.S. services, otherwise one of them would have developed it on its own in the first place. Systems of foreign origin consequently generally enter the picture not only rarely, but seriously handicapped. The marketing challenge involved for the U.S. and foreign firms is considerable. Their ability to identify the often ephemereal opening of a window of opportunity, and then to line up and sustain the support within the government is critical. The controversial, expensive and marginal requirements involved must persevere in the face of a highly fluid environment where administrations come and go and the politico-strategic situation of the world and tactical doctrines continue to evolve.

Most of this sub-chapter focuses on the debates within each nation over intra-national standardization (and secondarily international standardization) and the economies offered thereby, versus the specialized requirements of the national services. The interdependency of the parallel decision-making processes created a sort of 'chicken or egg' scenario. In the U.S., after the YF-16/YF-17 run-off collapsed (and along with it the attempt at USAF/USN standardization) in early 1975, the USAF pursued a course of international standardization for the F-16 with four NATO allies. The Navy on the other hand continued on an inter-service standardization course with its F/A-18 derivative of the YF-17 which was to be the next generation multi-role fighter and attack aircraft for both itself and its junior service, the U.S.M.C. Here too, intra-national standardization was only marginally successful and the F-18 has been adopted by Australia, and two NATO allies, Canada and Spain (with all three sharing in production), while the U.S.M.C. is buying (in addition to

a smaller quantity of F-18's) 340 AV-8B's for the ground support role in tandem with the RAF. Consequently, though intra-national standardization failed in each case, at least each service has been able to benefit from, and contribute to, international standardization (and the ensuing economic and operational advantages) by the wider range of fighters the U.S. is thereby able to collectively offer to its allies. The regional patterns created within NATO by this mix of international teaming arrangements is a major segmenet of the geo-political quilt of the Alliance.

The British found themselves in a similar dilemma to the U.S. with regard to intra-national standardization. The RAF requirement was different from that of the USMC in that it gave a higher priority to air-to-air combat and maneuverability for its planned deployment in Central Europe from dispersed sites. To further complicate the problem, Air Staff Target (AST) 403 was not only to be the Harrier GR.3 replacement, but was also to be the Anglo-French Jaguar tactical support fighter replacement which was caught up in tri-lateral plans including the Germans as well as the French. This situation eventually sorted itself out with the breakout of AST 409 in 1979 for an independent Harrier modernization program separate from the tri-lateral high performance fighter effort. In 1981 the final step was taken and the British opted to join the U.S.M.C. in procuring the AV-8B, be it their own version.

There is no set of pat answers to these trade-offs between standardization and specifically tailored requirements, but the convoluted history of the Harrier family of aircraft over the last quarter of a century offers another important data point, not only for Mode #4 of industrial collaboration but for all inter-

allied defense projects. Unlike the other programs in Mode #4 where the U.S. produced a modified version of the European system, in this case, the alternative followed was one involving the purchase of the British version of the aircraft on an off-the-shelf basis, plus further development (not simply modification) of the British developed system, (a choice which might have saved the system from a fate such as that suffered by the U.S. Roland). This procurement will have involved, as such, not only direct purchase, but was preceeded by joint funding of the Pegasus engine development (a low-level version of Mode #5) in the early 60's, arrangements for licensed production in quantity (Mode #4) which were not followed through on in the early 70's, followed by transatlantic co-development which was terminated after two years (Mode #5 again), being continued unilaterally (under license on the U.S. side); and has ultimately led to production in both the U.S. (and again through Mode #4) and the U.K. of an advanced version through cross licensing arrangements.

Along with another vintage inter-allied project, that of the Hawk family of SAM systems (covered in its successive stages on the NATO-Europe side in Chapters 7, 11, and 12), the Harrier story gives us a foretaste of how collaborative products evolve into follow-on projects and the arrangements for joint development and production that ensue.

[21]The French Exocet anti-ship missile was an other such system. The U.S. Roland is covered in detail later in this chapter.

[22]DMS Market Intelligence Report, "Hawker Siddeley Harrier," 1979, P.1.

[23]The German-American AVS project was actually dependent on the Kestrel's Rolls Royce engine.

[24]As a consequence of the U.S. Marine Corps' procurement of 110 of these aircraft, sales of defense equipment between the U.S. and Great Britain over the greater part of 1970s was about equal. The Harrier has been the most significant example of DoD's direct purchase of a major system from Western Europe.

[25]Aviation Week & Space Technology, March 2, 1970, p. 17.

[26]One of the other U.S. aerospace prime contractors, LTV Aerospace Corp., having expressed serious interest in production of the Harrier, had been Hawker Siddeley's backup choice in case the negotiations with McDonnell Douglas had failed. (Aviation Week & Space Technology, Sept. 1, 1967, p. 16.)

[27]Aviation Week & Space Technology, March 9, 1970, p. 36.

[28]"McDonnell Douglas/BAe AV-8B Harrier II," Air Force Magazine, December 1981, p. 143. (hereinafter referred to as 'A.F. Magazine').

[29]Ibid.

[30]GRC, op. cit., p. 3-4.

[31]A.F. Magazine, op.cit.

[32]Ibid.

[33]"Royal Navy Orders Ten More Sea Harriers," Aerospace Daily, May 26, 1978, p. 152.

[34]"Sea Harrier Makes First Flight at Dunsford," Aerospace Daily, August 28, 1978, p. 257A.

[35]Coincidentally, the F-18 was also an advanced variant of another firm's aircraft developed under license by McDonnell Douglas. The F-18 was a navalized variant of Northrop's YF-17 which lost out to the YF-16 in a USAF source selection in mid-1975. McDonnell Douglas and Northrop produce the F-18 under a similar sort of 60:40 teaming agreement.

[36]Clarence A. Robinson, Jr., "AV-8B Pivotal in Naval Aviation Fight," Aviation Week & Space Technology, October 31, 1977, p. 18.

[37]Ibid., pp 19-20.

[38]"Advanced Harrier Support Arises in Senate," Aviation Week & Space Technology, October 31, 1977, p. 18.

[39]Aerospace Daily, January 15, 1979.

[40]Aviation Week & Space Technology, January 22, 1979.

[41]Aerospace Daily, January 26, 1979.

[42]Aviation Week & Space Technology, February 5, 1979.

[43]Aerospace Daily, July 6, 1979, p.27.

[44]Aerospace Daily, April 3, 1979, p.163.

[45]Ibid.

[46]Ibid.

[47]"Marine Corps makes final plea for AV-8B", Aerospace Daily, March 9, 1979.
[48]Ibid.
[49]Ibid.
[50]"Hill Committees Consider Administrations Deferral of FY'79 AV-8B Money," Aerospace Daily, March 21, 1979, p.101.
[51]Ibid.
[52]Ibid.
[53]Ibid.
[54]David R. Griffiths, "AV-8B Funds Released, Congress Support Rising," Aviation Week & Space Technology, April 4, 1979, p.16.
[55]"DoD Reversal Brown Releases FY '79 AV-8B Funds," Aerospace Daily, March 29, 1979.
[56]Ibid.
[57]"Navy awards contract for first phase of AV-8B Full Scale Development," Aerospace Daily, April 23, 1979, p.262.
[58]Griffiths, op.cit.
[59]"Navy Awards Contract...," op.cit.
[60]Ibid.
[61]"House Armed Services Unit Adds $180 Million for AV-8B," Aerospace Daily, May 4, 1979, p. 22.
[62]Ibid.
[63]"AV-8B Program Manager Cites Reasons for Optimistic Production Outlook," Aerospace Daily, June 7, 1979, p.183.
[64]Ibid.
[65]Ibid.
[66]Ibid.
[67]Ibid.
[68]"Other Customers Needed for Av-8B, New Marine Corps Chief Says," Aerospace Daily, July 6, 1979, p.26.
[69]Ibid.
[70]Ibid.
[71]Ibid.
[72]"McDonnell Douglas Team to Visit British," Aviation Week & Space Technology, October 15, 1979, p.65.
[73]Ibid.
[74]"AV-8B Crash Seen Having Little Impact on Full Scale Development Program," Aerospace Daily, October, 19, 1979, p.92.
[75]Ibid.
[76]Interavia Air Letter, January 29, 1980, p.2.
[77]"Brown remains unconvinced on AV-8B," Flight International, January 5, 1980, p. 9.
[78]Ibid
[79]Ibid.

[80]Ibid.
[81]Aerospace Daily, april 24, 1981, p.316.
[82]"Most Aircraft Programs gain in Reagan Budget Revisions," Aerospace Daily, October 19, 1982, p.81.
[83]"AV-8B+ Capable of 'Variety of Missions,' Navair Report Says," Aerospace Daily, March 19, 1979.
[84]Ibid.
[85]Ibid.
[86]Ibid.
[87]Ibid.
[88]Ibid.
[89]"Enlarged wing proposed for Harrier retrofit," International Defense Review, 3/1979, p. 318.
[90]Ibid.
[91]Ibid.
[92]Ibid.
[93]Ibid.
[94]"Royal Air Force Eyes New, Larger Wing for Harriers," Aerospace Daily, April 6, 1979, p. 183.
[95]Ibid.
[96]Ibid.
[97]"U.K.: Harrier Data Evaluated," Defense and Foreign Affiars Daily, December 4, 1979.
[98]"U.K. Restarts AV-8B Evaluation," Interavia: Air Letter, March 28, 1980.
[99]Ibid.
[100]Ibid.
[101]"The Tinwing Temptation: Don't. Go Anglo-American Instead," The Economist, June 2, 1979, pp. 16-17.
[102]"Harrier II rolls out at St. Louis," Flight International, 24 October 1981, p. 1228.
[103]A.F. Magazine, op.cit.
[104]Ibid.
[105]"Harrier II rolls out at St. Louis," op.cit.
[106]Ibid.
[107]Ibid.
[108]Ibid.
[109]Ibid.
[110]Ibid.
[111]Ibid.
[112]Ibid.
[113]Ibid.

[114]U.K.: Supersonic V/STOL Reviewed in the U.S.," Defense and Foreign Affairs Daily, July 3, 1980.
[115]Ibid.
[116]Ibid.
[117]Ibid.

E. The French RATAC

1. Historical Background

The French RATAC radar again involves a combination of two means of transferring technology to the U.S., a case falling somewhere between those adopted for the USMC. Harrier and the U.S. Army Roland II systems. First, the RATAC system involved the transfer of the technology of a foreign-developed system to the U.S. through direct purchase of equipment for deployment with the U.S. Armed Forces as with the Harrier. Secondly, the production rights to the system were purchased for the purpose of modifying this French radar system so that it could be produced in the U.S. to modified specifications as with the Roland II. (The acquisition of the Harrier's data package was intended not simply for modification as the RATAC, but as the basis for the development of an advanced version).

The original family of radar developments to which RATAC belonged initially began in 1963 as a cooperative program between France and the FRG and involved partial U.S. funding through the Mutual Weapons Development Program (MWDP). The principal development contractor was an ITT affiliate in France, Laboratoire Central de Tele-Communications (LCT).[118]

The war in Vietnam created an urgent need for the U.S. Army to replace its existing ground surveillance radar, the AN/TPS-25. In order to fulfill the immediate combat need, the U.S. Army initiated action through the ENSURE (Expedited Non-Standard Urgently Required Equipment) procedure. The French

RATAC ground surveillance radar seemed promising. Accordingly, the U.S. Army proposed a 60-day loan of the RATAC for testing to ensure that it performed at the required level. After testing, the Army decided on a two-phase acquisition program. First, because of the urgency of the requirement in Vietnam, the Army purchased 24 of the radar systems directly from LCT. The second phase involved the Americanization of the RATAC to meet U.S. military and production standards. The Americanized RATAC, designated AN/TPS-58A, was to satisfy the remainder of the U.S. Army's world-wide needs.[119]

The acquisition of 24 sets cost the U.S. Army $6 million. This was 50 percent more than initially estimated. More importantly though, since schedule was the key factor, most of the radars were delivered with only minor schedule slippage. As for performance, radar reliability was less than expected and less than claimed by the manufacturer but was about as good as contemporary U.S. electronic equipment. Overall, the phase involving direct purchase of RATAC radar for Vietnam was considered to have been a successful transfer of technology.

The Americanization phase of the program was more controversial. This phase resulted in a 100 percent cost overrun, and schedule performance was poor. The first unit, having been promised for delivery 26 months after contract approval, was not delivered until 45 months after authorization, and reliability was less than satisfactory as well. The Americanization of RATAC was viewed by many as a mistake, though this remains debatable.

As in the previous cases of the English Electric Canberra (USAF B-57) and the Hollandse Signaal Aparaten WM/22 Gun Fire Control System (USN MK-87, MOD 0 Gun FCS), the military service concerned had decided at the outset that in order render the system producible, it would have to be Americanized. The Army Electronics Command (USAECOM) selected ITT Gilfillan (ITTG), whose parent international organization, ITT, had existing licensing agreements with both the French developer and the American producer. The Army's choice of ITTG was deliberate, with the expectation of reducing data transfer problems. Though the problems were still numerous, it was felt that they would have been more severe had this particular arrangement not existed.[120]

One problem that surfaced almost immediately was that the DoD's Armed Services Procurement Regulations (ASPR) required the examination of the contractor's financial records as a pre-condition to the payment of development costs. When the French Ministry of Defense refused, however, the DoD relented, granting an exemption.

2. Data Acquisition, Test Data and Equipment, and Drawing Conversion

Problems were encountered in defining what constituted data and what constituted tooling. Printed circuit boards are considered tooling in France, and as such the necessary data was not provided. The U.S. purchase agreement included the purchase of French and German Government proprietary data rights, but much to the surprise of the DoD, industrial proprietary data rights were not included.[121]

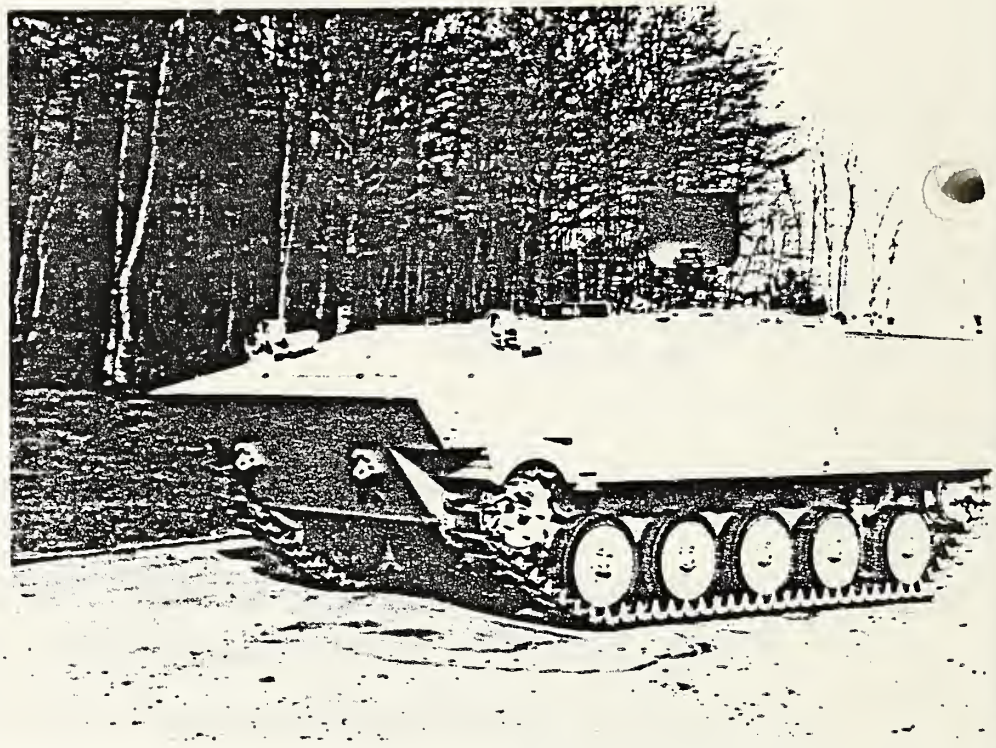
FOCUS ON FRENCH ARMAMENT



reconnaissance units at army corps and division level.

It has the same power-unit, hydraulic torque converter, preselective gear box and steering differential as the AMX 10 P. Its skid steering is the same as in tracked vehicles. Six driving wheels are fitted with 14.00 x 20 XL tires. Joint transmission is in armoured vanes from both sides of the vehicle through rocker-type gearing. Olea-pneumatic suspension with variable trim and ground clearance enables the vehicle to travel at high speed over rough terrain. Top highway speed is 85 km/hr; road autonomy 300 km; combat autonomy 36 hours; top speed in water with hydrojets 2m/sec; slope climbing 60%; ditchspanning ability is 1,60 m; obstacle climbing wall is 0,70 m high.

The armament includes a 105 mm gun firing high-muzzle velocity hollow-charge fin stabilized rounds – The 7.62 mm machine gun is coupled to the gun.



The AMX 10 RATAC is derived from the AMX 10P Equipped with a RATAC (fire radar for field artillery) it is designed for identification of moving targets such as armoured vehicles, pedestrians, wheeled vehicles and intended for artillery regiments. The radar dish replaces the TH20 turret. There is an automatic elevation and slant corrector. A tracing table, servo-controlled by the radar, enables the travel of the detected moving targets to be scanned on a map. a crew of five.

Governments other than the U.S. do not generally acquire these rights, nor are they allowed to place them freely at the disposal of third parties. In the FRG for example, the contractor as a rule retains title to the inventions resulting from research and development contracts let by the government, while the government only retains a non-exclusive license for the resulting R & D work.[122] In the case of the U.S. purchase of 24 RATAC sets plus the French and German Governments' title and interest in the TPS-58, the industrial property rights were not included and did not pass to the U.S.[123]

The industrial proprietary rights were later offered to the U.S. Government for an additional $1.4 million, but the offer was refused. Considering the price unreasonable, the U.S. Army decided to re-engineer the components concerned rather than obtain the data rights from the French manufacturer. In any event, many of these items purchased to form, fit, and function specifications were found to have improved performance over their original counterparts, as well as being more economical.[124]

Test data could not be procured from France, there apparently being none. Tests were conducted at Fort Sill, Oklahoma, by the U.S. Army in 1969, during a 60-day loan period for appraising the system's potential. Additionally, the foreign-built test equipment had to be re-engineered or modified to incorporate U.S. standard components, such as meters.

ITTG decided early in the program to translate production drawings from French into English for its own use and for issuance to U.S. subcontractors where components were to be procured. In addition, it was decided that dual dimen-

There were a number of areas where modifications were required in order to meet U.S. production standards and tests:

- U.S. safety standards are more stringent than in Europe and electronic components in the French design were found to be overstressed by U.S. standards and had to be changed;
- the generally poor design of European fasteners in respect to thread-to-shaft ratios dictated the substitution of U.S. standards;
- European power supply voltages vary from country-to-country and require equipments to be modified to accept U.S. military standard power supplies;
- variations between European mill-rolled metal guages and alloys, as compared to U.S. standards, required re-engineering of European designs to U.S. production standards.[128]

One additional such area where redesign was required resulted from the more severe environmental requirements of the U.S. An example of this is the moisture-proofing necessary to satisfy conditions of world-wide deployment of the U.S. Armed Forces. Wider spectrums than in most Western European countries also exist for temperature, humidity, salt air, salt water, high altitude, velocity, shock and vibration. A specific example of redesign required to meet the U.S. situation and useful life tests involved printed circuit boards. Meeting U.S. high-reliability (HIREL) standards required an increase in the radius of the wire, which in turn required a redesign of the circuit board layout. Meeting the U.S. environmental standards called for a total redesign of the circuit boards.[129]

4. Maintenance, Supply and Training

Many European armed forces, among them the French, have a different concept of supply and maintenance, returning equipment to the manufacturer for all but minor repairs. Since little repair work is performed in the field, a smaller quantity of spare parts is normally provisioned. This created problems for ITTG in supplying spares for those French-produced units deployed with U.S. troops in South East Asia. "Floater units" were eventually deployed along with operational units, and cannibalized as the need arose.[130]

This maintenance concept difference also meant that field maintenance instructions and manuals were non-existent and therefore had to be developed. The same situation applied to training manuals, but for slightly different reasons. The French Armed Forces use long-tenure enlisted men with an accumulation of extensive on-the-job training for operations. The U.S. depends on the use of accelerated technical training courses for shorter term personnel, thus necessitating training manuals with a different orientation.[131]

5. Transfer Within A Multinational Corporation

One of the most significant aspects of the RATAC procurement—and one that is a program plus, offsetting many of the other problems—is the fact that the technology transfer took place between two affiliated firms, LCT and ITTG, both being subsidiaries of ITT. This simple fact meant the transfer of this system was better coordinated than might otherwise have happened. Negotiation of the U.S. contract with ITTG negated any need for a license from LCT, all

AN/TPS-58A data being retained within the ITT international family. "Management arrangements of the type represented by ITT could help improve the use of international standards and international testing methods to be conducted during the original development of the items subsequently chosen for U.S. production."[132]

[118]GRC (1976), op. cit., p. A-13.

[119]Richard J. Trainer, Barriers to the Transfer of Military Systems Technology to the United States, Director of Systems Review and Analysis Office, Headquarters, Department of the Army, 1975, p. 8.

[120]GRC (1976), op. cit., p. A-14.

[121]Trainer, op. cit., p. 9.

[122]Ibid.

[123]See NATO Document AC/94-D/258, Working Group on Industrial Property, "National Law, Policy, and Regulations Concerning Procurement of Defense Material in which Industrial Property Matters are Involved," 25 April 1975.

[124]GRC (1976), op. cit., pp. A-14 and A-15.

[125]Trainer, op. cit., p. 9.

[126]GRC (1976), op. cit., p. A-15.

[127]Ibid.

[128]Trainer, op. cit., p. 10. This latter problem was also an unexpectedly serious problem for the Canberra/B-57 program.

[129]Ibid.

[130]GRC (1976), op. cit., p. A-15.

[131]Ibid.

[132]Ibid., p. A-16.

F. The Franco-German ROLAND II

1. Background

The production of the Franco-German Roland II under license in the U.S. by the Hughes Aircraft Company and the Boeing Aerospace Company has been one of the most significant programs within the U.S. Government's NATO Rationalization, Standardization and Interoperability (RSI) drive. This program represented the first serious effort since the selection of the British Canberra bomber (USAF's B-57) in 1951 to produce a major weapon system previously designed and developed in Western Europe, on a large scale for the U.S. Armed Forces. Unlike the B-57 however, this time a high degree of interchangeability with the original European system was to be maintained.

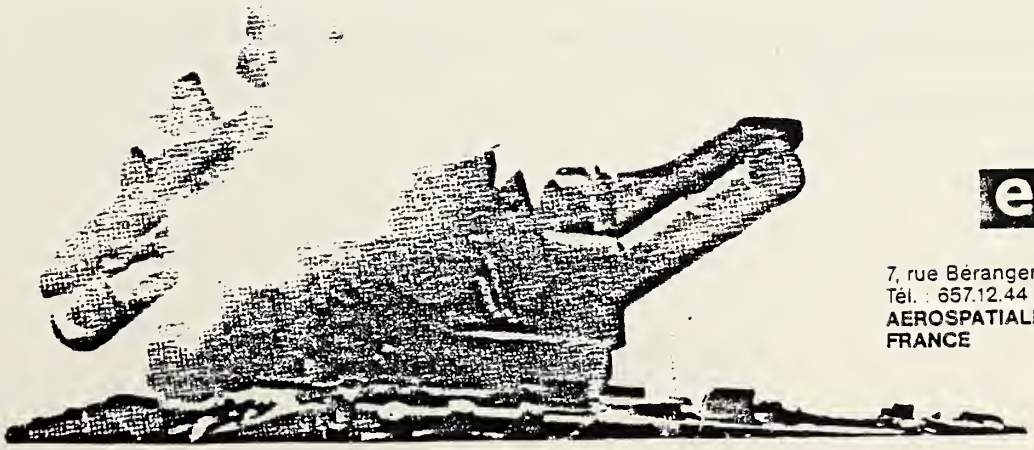
The significance of the U.S. Roland program stems from two aspects of the experience:

- The process of learning the nuts and bolts of actually transferring technology from Europe to the U.S. for its conversion and adaptation to U.S. user and manufacturing requirements.

- How Europeans and Americans view the NATO RSI policy generally, and more specifically U.S. claims of an intent to attain this goal through a more equitable distribution of benefits by encouraging a "two-way street" in the movement of hardware and technology across the Atlantic;

ROLAND





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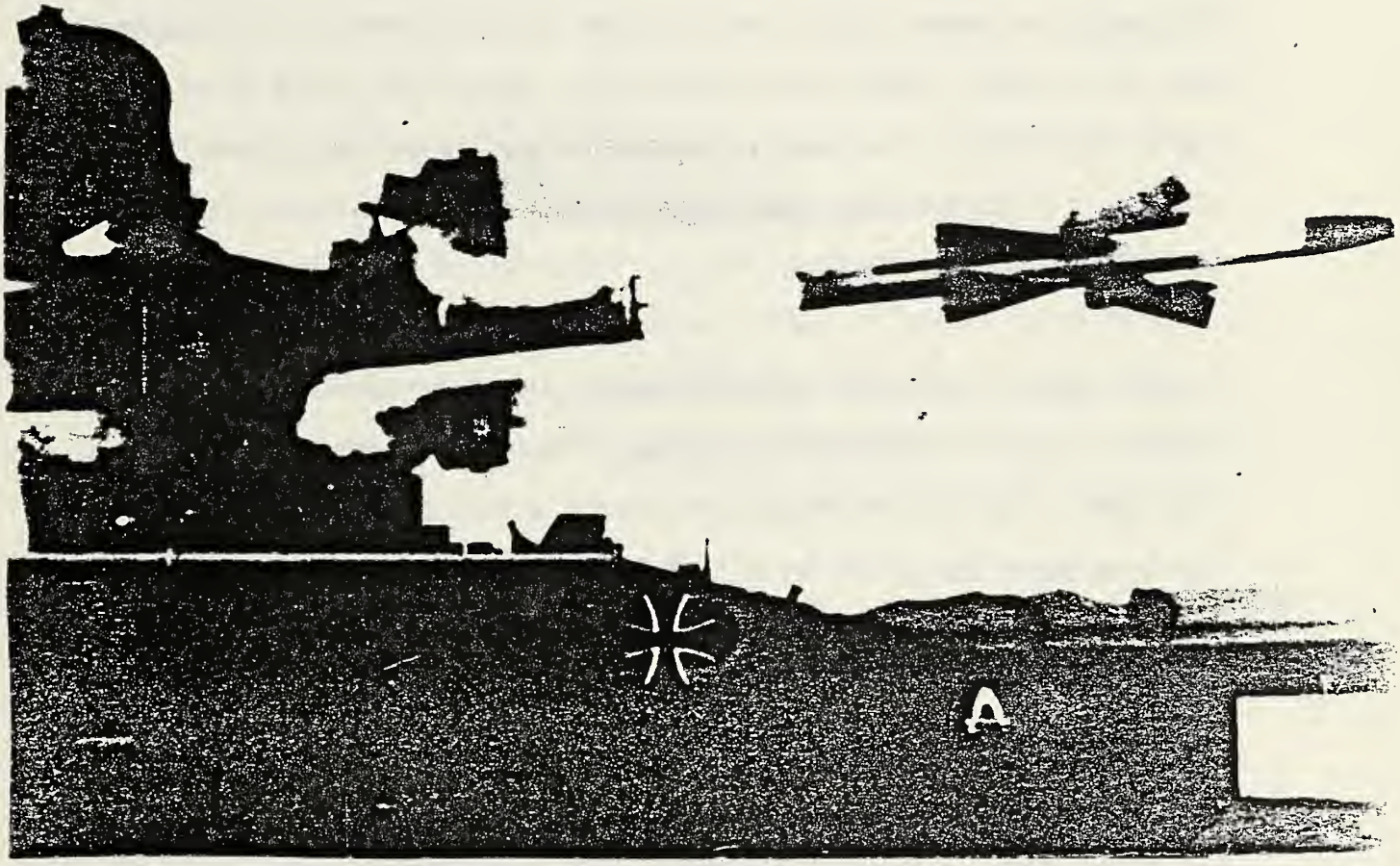
Due to both of the above, this program has been a highly visible one, involved a great deal of turbulence, and has found itself at the center of much controversy.

a. The System

The Roland II is an all-weather, highly mobile, short range air defense system that can locate, identify and destroy targets at low altitude. It can engage targets at a distance of up to 6 kilometers.[133] The Fire Unit has a fully integrated fire control and missile launching system requiring a crew of two to four men.[134] It can search while moving and need stop only to fire.

The Fire Unit for the Roland II system, consisting of twin missile launch arms on a revolving turret, houses search and track radars, an electro-optical sight, and IFF interrogation for all-weather operations, and includes, crew stations and an environmental control system. A mod to provide Nuclear Biological and Chemical (NBC) warfare protection was cancelled when the program was restructured for the second time in 1981.

The missile load consists of one missile on each of the launch arms plus two magazines of four missiles each, for a total of ten missiles. The Roland II missile is command-guided and can be tracked by flare or beacon. For clear weather operations, a flare provides the source for infrared optical tracking; and for night-time and poor weather operations, a radio beacon provides emissions for radar tracking.[135]



Roland II Source: MBB

While the U.S. Roland system was originally to be mounted primarily on the Army's M109 tracked vehicle, its modular design enabled it to be employed on either wheeled or tracked vehicles, on a trailer, or at fixed ground locations as it is helicopter-transportable. Ultimately, with the reduced buy of 27 fire units and 595 missiles, the tracked vehicle option was dropped. The U.S. Army originally planned to utilize the U.S. Roland in the field at the Army Corps level and for air base defense, in both cases heavily oriented toward deployment in central Europe, but, in 1981 switched them to the Rapid Deployment Force (RDF). The system can be lifted and carried by the CH-47D or CH53-E helicopters. Two modules can be carried on a C-141, a module and a truck on a C-130 under wartime provisions, or several full-up systems can be carried on the C5-A.

Norway, Canada, and Korea expressed strong interest in purchasing the U.S. Roland, during the life of the program. The first of these, Norway, was reportedly within several months of signing a U.S. Government Letter of Offer and Acceptance (LOA) when the U.S. Roland program was terminated by the new Administration in September 1981.

b. The U.S. Requirement

The decision to pursue the production of the Roland II in the U.S. was hailed throughout the second half of the seventies as a significant step in the DoD's promotion of NATO RSI. It was to save the U.S., according to some early estimates, $500 million in R&D costs, while filling a major void in U.S. air defense.[136] One study, according to Roland project manager Gen. F.P. Ragano

in 1977, showed that developing such a system from concept definition to low-level production would have cost $1.2 billion and taken 8-10 years. In any event, the U.S. transferred the technology from Europe, produced four systems and successfully tested them in less than four years and at a cost of just under $300 million.[137]

The history of the U.S. Army requirement for a Short-Range Air Defense System (SHORADS) goes back to the early 1960s and the Mauler program, the development of which was cancelled in 1963. Shortly after the cancellation of the Mauler program, France and the FRG decided to enter into a joint development effort to produce a clear weather system, Roland I that could counter the low-altitude threat postulated at that time. The two governments signed a protocol agreement initiating the program in October 1964. France selected Nord-Aviation (a future component of Aerospatiale) and the FRG, chose Boelkow (shortly to contribute the second letter to the MBB team), as their respective industrial participants. This later led to the development of an all-weather version beginning in 1972, the Roland II.

France's first series production Roland I fire unit, mounted on a French Army AMX-30 tank chassis, was rolled out in January 1976. The French Army is expected to receive 144 Roland I and 70 Roland II fire units plus 10,800 missiles. The German order originally included 343 Roland II fire units to be mounted on their Marder SPZ APC chassis, and 12,200 missiles.[138] The first five Roland II fire units were delivered to the German Army in 1977, together with 80 missiles. The remainder of an initial German Army order of 143 were turned over progressively through 1982. The Luftwaffe was also to receive an

order of 200 Roland II systems for air base defense between 1983 and 1988, but this was indefinitely deferred in 1981.

Shortly after cancellation of the Mauler by the U.S., the United Kingdom also inititated their own SHORADS development program, the BAC Rapier, which later became the Rapier/Blindfire in its all-weather version. This latter version resurfaced in the early 1980's to obtain a 32 fire unit order from the USAF for deployment at its UK air bases.

In 1964, France's Thomson-CSF decided to capitalize on the know-how and technology acquired from Raytheon during the NATO Hawk medium altitude surface-to-air missile system program and initiated development of the Crotale SHORAD system for the Republic of South Africa. The R.S.A. never bought the system, but instead it was procured by France's Air Force (the Roland I having been procured by the French Army) as well as several foreign customers. Engins Matra, France's premier air-to-air missile firm was the main subcontractor to Thomson-CSF for the Crotale, being responsible for the missile itself.[139]

Meanwhile, the U.S. produced a clear-weather-only system, known as the Chaparral to provide an interim solution to the short range requirement. In the late 1960s following a number of U.S. air defense studies, a growing need for an all-weather, short-range system was recognized.[140] In 1969, Philco-Ford's Aeronutronics Division and RCA's Defense Products Division were teamed to bid on a system, at that time designated as a Low-Altitude Forward Area Defense System (LOFAADS), but this too was dropped for higher priority items.

In mid-1970, the OSD issued a directive stressing greater cooperation with our allies in research and development, while maintaining a U.S. production base for all such programs. A U.S. requirement for an all-weather SHORAD system finally re-emerged in 1973. This came about after analysis indicated the need for such a low altitude, highly mobile system for operations in Central Europe with all-weather capability where long periods of low-visibility seriously limited the effectivness of the clear-weather systems in countering an increasing Warsaw Pact air threat.[141]

c. The U.S. Competition

Faced with this requirement the DoD had three options: make the current Chaparral an all-weather system; start a new U.S. development program; or deploy a European system.

The DoD told Congress in FY73 that the acquisition of a foreign all-weather system would save from $200 million to $400 million in R&D costs. Meanwhile the Army had been testing and evaluating the three European low-altitude air defense missile systems. Although all three systems were still in various stages of development, they were all judged to be capable of meeting U.S. requirements.[142] The idea of buying a missile system from a foreign country, however, even if licensed to a U.S. manufacturer, was still a difficult decision for the Army and the Congress to make, and funding was kept low.

Finally, in July 1974, the Army issued an RFP, and of the 21 sources solicited for proposals, four responded: Philco-Ford, with an all-weather version of the

Chaparral, and the three licensees of the European systems - Rockwell International with Crotale; the Norden Division of United Technologies and McDonnell Douglas with Rapier/Blindfire;[143] and the Hughes/Boeing team with the Roland II.

Developing an entirely new system would have represented an 8 to 10 year effort and a very great expense. Chaparral upgrading, envisioned as adaptation of an IR search system and an IR night sight, would still not produce an all weather capability. In addition, the large crew and noncertified round caused normal operational costs to be high.

Of the three foreign developed systems under consideration by the U.S. Army, Crotale was the most technically sophisticated, had a high single shot kill probability and used certified rounds. However, only four missiles were carried on the launch unit, and two vehicles were required with a third vehicle for reloading. This, the large crew required, and the high initial investment all added up to what was assessed to be a prohibitively high life cycle cost.

Rapier was multi-vehicle system and manually operated. Although it had the lowest initial investment and unit missile costs, its large crew and noncertified rounds caused life cycle costs to be high. Its contact fuzed, hit to kill warhead provided acceptable single shot kill probabilities when optically guided, but with the all-weather track radar was judged as only having a marginally acceptable kill probability.

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The FlaPz Roland chassis is manufactured by Rheinstahl AG (West Germany)

The Roland II was a semi-automated, highly mobile system on a single vehicle. It's small crew requirements and certified round help keep life cycle costs down. In addition, the system had a high single shot kill probability in both clear weather and all weather operations.

In January 1975, the Hughes Boeing team was awarded the Technology Transfer, Fabrication and Test (TTF&T) contract to build five U.S. Roland fire units and 126 missiles.

2. The Industrial Team

a. The Team Takes Shape

The Roland system was developed jointly by Boelkow of the FRG (absorbed into MBB in 1968) and France's Nord-Aviation (merged into Aerospatiale in 1969). Through the Paris based consortium comprised of these two firms, Euromissile, they have jointly licensed Hughes and Boeing to produce the U.S. version. Initially Hughes was the U.S. Army prime contractor and Boeing the principal subcontractor. Work was distributed on roughly a 50-50 basis between the two U.S. firms. Following TTF&T, the government contracted with the two companies for low-rate production (LRP) as associate prime contractors to reduce costs for the program.[144]

The licensor, Euromissile, is a Groupement d' Interet Economique (GIE) set up under a French law dating from 1967, with MBB and Aerospatiale each having a 50 percent share. A GIE is a legal framework for the merger of commercial activities, but not assets (i.e., development and manufacturing activities ordinarily remain within the parent companies). However, in the case of Euromissile, MBB and Aerospatiale have not only entrusted it with sales and marketing but also the industrial management of on-going programs. Euromissile is also responsible for two other joint programs of MBB and Aerospatiale, the HOT and Milan anti-tank missile systems.[145] At the government level all three of Euromissile's programs are under the direction of a joint French-German Program Office also located in Paris.

UNITED STATES ARMY

The Euromissile[146] industrial team, in addition to the two owners, includes 14 major subcontracting firms. The German subcontractors were:

- AEG-Telefunken	Command Computer, Transmitter and Receiver Antenna
- ELTRO	Goniometer, Optical Sight (lower section), and electronic components
- Gabe Lameyer	Hydraulics
- SEL	Converter/Inverter
- Siemens (both in the FRG and Belgium)	Surveillance Radar, later the track radar (production only)

The French team included:

- Air-Equip	Rate Gyro
- SAGEM	Optical Tracker (upper section)
- SAMM	Hydraulics
- SAT	Goniometer
- SNPE	Missile Propellant
- SORELEM	Hydraulic Activated Connector
- STRIM	Safe and Arm Device

- Thomson—CSF — Track Radar
- TRT — Proximity Fuze

In addition, MBB's Schrobenhausen division operated in the capacity of a subcontractor to SNIAS for the missile warhead.

In early 1972, prior to the accords with Euromissile for a General Agreement in October 1972 and the Licensing Agreement in November 1973, Hughes and Boeing, both interested in the Roland II, had decided to team up to produce the system as licensees in the U.S. Back when the U.S. Army began to accelerate its LOAFAADS efforts in 1970, Hughes, with its extensive background in air defense, became interested. The issuance in November 1971 of a memorandum entitled "Licensing Agreements between U.S. and Foreign Companies on Foreign-Developed Items," then Deputy Secretary of Defense Packard gave further impetus to the Hughes efforts. Hughes was well positioned, having operated very effectively in the European markets for some time, both selling its own products — avionics, helicopters and tactical missiles — and as a partner with Europe's principal electronics firms in the NATO Air Defense Ground Environment (NADGE) project. This allowed them to maintain high visibility, close contacts, and solid working relationships with numerous European national governments and firms.[147]

Boeing, for its part, had been attempting for several years to develop a position specifically as a licensed producer of European tactical missiles - an area in which the European aerospace and electronics firms were beginning to excel. This had involved the licensing agreements with each of Euromissile's parent firms in 1971: Aerospatiale for its Exocet MM-38 surface-to-surface

anti-ship missile and MBB for its Komoran air-to-surface anti-ship missile.[148] These had given Boeing some good experience in this area[149], but at the expense of a somewhat tarnished credibility due to Boeing's inability to make either of them pan out by getting the U.S. Armed Forces interested; the not-invented-here (NIH) factor still having an overwhelming weight in the consideration of foreign-developed systems at this time.[150] These two Boeing license agreements served as the model for the Roland license, greatly facilitating the agreement between the four firms the following year.[151]

In evaluating the Thomson-CSF Crotale,[152] the British Aircraft Corporation's (BAC's) Rapier/Blindfire, and the Franco-German Roland II, Hughes and Boeing both determined during 1972 that the Roland II, though considerably less mature than the other systems, was the best choice, both technically and in terms of system acquisition and support cost. However, as was later pointed out by John Richardson, Hughes V.P. at the time, "Our concept was that the European system would be ready for true second source production in the U.S. without any changes being made to the system. This proved to be a rather naive point of view since there had to be a few, though not many, changes made to meet U.S. Army requirements".[153]

Of the ten written proposals submitted to Euromissile, four or five contenders were invited to participate in a final round of discussions and negotiations. It was at this point that Hughes and Boeing decided that they could optimally produce the system working as a team, i.e., as joint licensees. Another consideration reinforcing this conclusion was that Aerospatiale already had an existing working relationship with and preference for Hughes, while MBB had a

similar affiliation/preference for Boeing.[154] Consequently, in June 1972, a Teaming Agreement was signed by Bill Lambert, Director of Contracts of the Boeing Aerospace group and Leonard Gross, Vice President, Assistant Group Executive Engineer of HAC. It established the roles of the two companies in acquiring a Roland License and subsequent Army business.

A General Agreement was signed in October 1972 between Euromissile and the two U.S. firms, which served as the basis for the formal license granted by Euromissile in November 1973, to be effective on the date of contract award by the U.S. Army. The parties negotiating the License Agreement attempted to achieve a balanced arrangement of the rights and obligations imposed on each. Simplicity in both the licensing agreement and the Hughes/Boeing working relationship was emphasized throughout.[155]

It is important to keep in mind that the Hughes and Boeing decisions to seek a license for Roland were taken in 1972. The Army requirement for SHORADS was not validated until after the findings of a special task force in the summer of 1973. Even then, a question remained as to whether the procurement would be forthcoming. The RFP was issued in July 1974, industry responded to it in September, and the Army made its choice in January 1975, almost three years after the Hughes/Boeing license decision.[156]

During the license negotiations, Hughes/Boeing and the other U.S. firms had little guidance from U.S. government sources as to what elements the license should contain. There was no validated Army requirement at that time for the

system, and no one in the Army, moreover, appeared to be in favor of procuring an off-shore development.157

As the U.S. licensees subsequently learned, it is more difficult to negotiate for additional rights after an agreement on a license has been reached. The loose Hughes/Boeing relationship, and the dissimilar company methods could have led to significant problems. Their interest in keeping things on track however has caused these tensions to be far less significant than the achievements of this inter-company management challenge.158

b. The License Agreement (i.e. fees, royalties and territories)159

The relationship between the licensor, Euromissile, and the American team of Hughes Aircraft Company (HAC) and Boeing Aerospace Company (BAC) is defined in the General Agreement of October 1, 1972. This agreement was further amplified by a License Agreement of November 9, 1973, 13 months later, which granted Hughes and Boeing the right to build the Roland II for the U.S. Army. The license was later amended to grant, among other things, HAC and BAC the right to manufacture the Roland System for specified third countries. The License and its Amendments were subject to acceptance by the French, German and U.S. Governments.

The Licensing Agreement as amended provided for the payment in Deutschmarks of the following nonrecurring royalties (licensing fees):

1. DM 5.1 million upon the effective date of the licensing agreement;

2. DM 7.61 million upon the issuance of a contract for Low Rate Initial Production of Roland in the U.S.;

3. DM 8.522 million upon the issuance of a contract to the licensee for the Initial Production of Roland in the U.S.; and

4. DM 64.1 million paid in installments upon issuance of a contract to the licensee for serial production of Roland in the U.S. at the rate of DM 160,000 for each fire unit ordered, and DM 1,600 for each missile ordered until the sum is fully paid.

Recurring royalties are based on the sales price as follows:

1. For sale to the U.S. Government for its own use or for delivery free of charge the third countries, the industry average of 5% was applied but broken up as follows:

   6.5% for cumulative sales up to $200,000,000

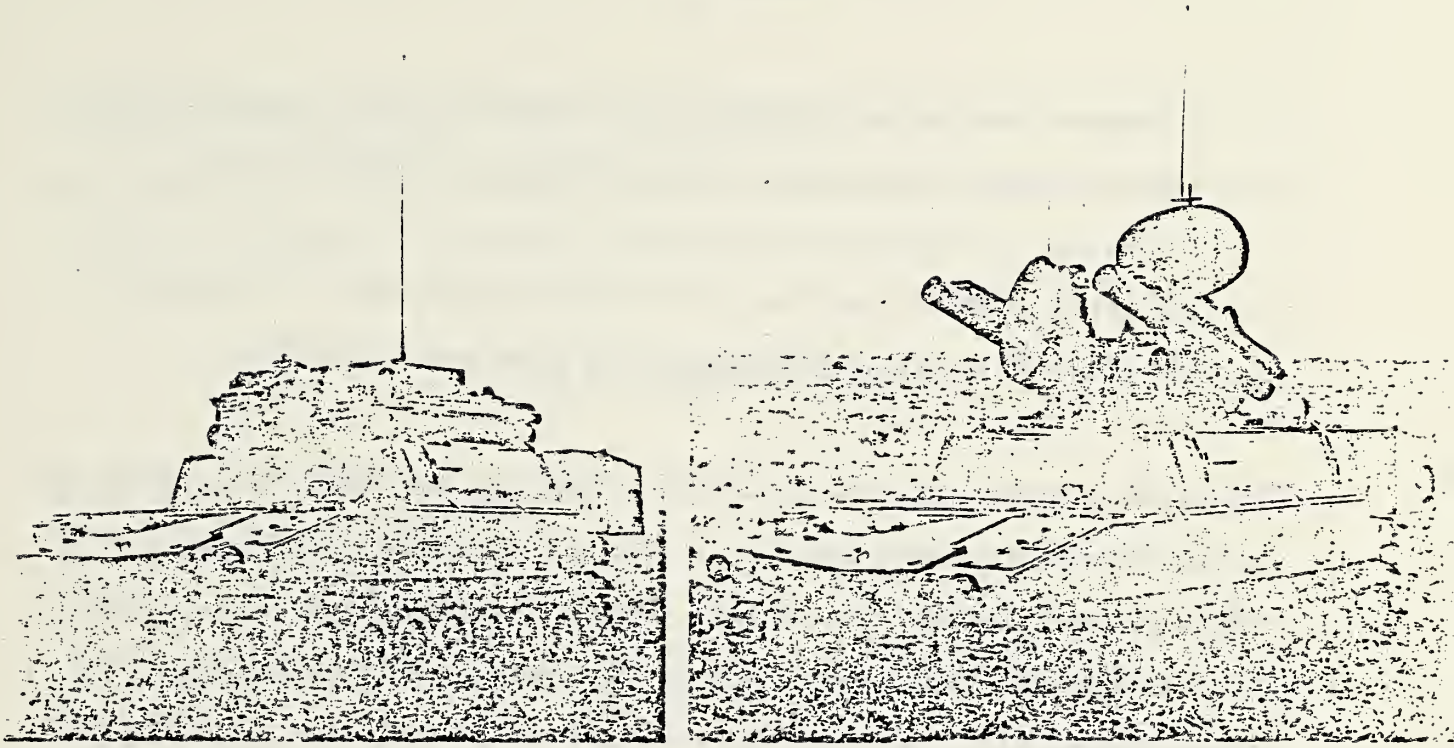
   5.5% for cumlative sales from $200,000,001 to $400,000,000

   4.5% for cumulative sales from $400,000,001 to $600,000,000

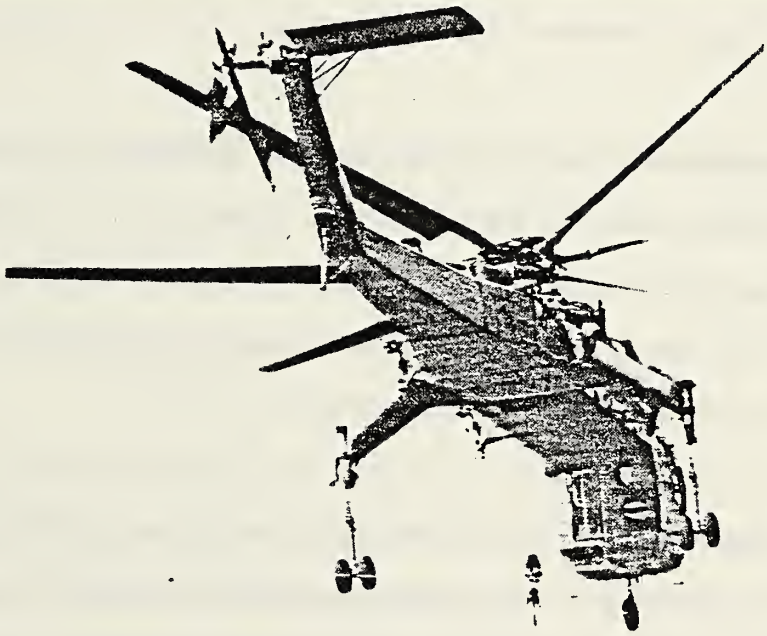
   3.5% for cumulative sales over $600,000,000.

   What was atypical is the structuring of this rate over time (but representative of the highly defensive posture of the Europeans on data transfer). The ordinary approach to royalties is either a flat line or an

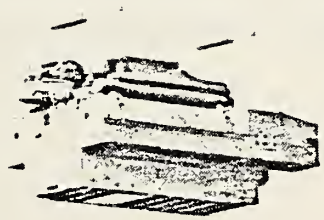
U.S. Roland



Source Aviation Week
& Space Technology



Source: Hughes Aircr
Company



increasing rate as the program picks up momentum, not a regressive rate that represents yet another hurdle to getting it off the ground.

2. For sales to third countries or to the U.S. Government for resale to third countries, the royalty was to be an unusually high 16%.

The third countries included in the U.S. licensees' territory are: Canada and Norway[160] (all other NATO members are within Euromissile's territory), Israel, the Phillipines, South Korea, Taiwan, Jordan, plus Central America. Subject to prior approval, sales could be made to certain South America countries on a case-by-case basis. To Norway the U.S. contractors could sell only fire units as missiles were reserved by Euromissile.

For improvements originating with the U.S. licensees, Euromissile could incorporate them on a royalty free basis for sales to the FRG and France, but would have to pay royalties (in U.S. dollars) amounting to .75% of their sales price to other NATO member states and 1.5% for sales to non-NATO third countries after the start of full rate production in the U.S..

The U.S. Department of State's Office of Munitions Control of course retained the right to approve or disapprove such export of technical data on a case-by-case basis. Naturally this was a source of irritation to the Europeans.

Though HAC and BAC became associate contractors for the Low Rate Production (LRP) program, Boeing continued to submit its share of the royalty payments to

Euromissile through Hughes. As a substantial fraction of the Boeing end product was actually bought directly from Euromissile, the value of this procurement was subtracted from the base upon which the royalty was figured.

c. The U.S. Industrial Team

Since the Army preferrred that one of the two co-licensees assume the role of prime contractor and the other the role of principal subcontractor for the TTF&T contract, Boeing agreed to Hughes assuming the role of prime contractor. The reasoning behind this was the well-established relationship of long standing that Hughes had with the U.S. Army - something Boeing did not have at this time, but was interested in developing.[161]

Following the TTF&T phase the two firms reverted to the associate contractor relationship originally contemplated. Consequently, the two firms signed a U.S. Roland Program Associate Contractor Policy Statement and a corresponding Operating Agreement in February 1979.[162]

The U.S. Roland production program was originally expected to run through the 1980s. Hughes' and Boeing's equal shares of the U.S. Roland sales to the U.S. Army were estimated in 1980 at more than 3/4 of a billion dollars each, with foreign sales adding a possible $200 -$500 million for each firm.[163]

Hughes had the systems integration responsibility and performs final assembly of the missile, as well as building the missile guidance and proximity fuse, the optical tracking sight, and the search and track radars. Boeing was

responsible for the missile warhead and propulsion systems, plus the fire unit. The fire unit includes both the module body and the turret. The module contains fire control equipment, crew seats, power supply and radar displays. The Surveillance and track radars (HAC), command guidance transmitter (BAC), optical sight (HAC), command computer (BAC)[164], and two missiles launchers (BAC) are all housed in the turret of the fire unit. Whereas Hughes is responsible for integration of the radars at Boeing in Seattle, BAC is responsible for fire unit testing.

Another point of interest regarding the relationship between the U.S. and European teams is that, although the Aerospatiale/Hughes and the MBB/Boeing affilliations had been important until the licensing agreement was signed, since then, Hughes has utilized data primarily obtained from MBB, and Boeing from Aerospatiale.[165] In line with this relationship, the nationality of the permanent Euromissile representative at each of two U.S. firms' plants has been: French (i.e., Euromissile/Aerospatiale) at Boeing; and, German (Euromissile/MBB) at Hughes.

Of the 11,000 suppliers that participated with Hughes and Boeing in the TTF&T phase, those U.S. suppliers with purchase orders of $100,000 or more were:

Agnew TECH TRAN	-	translation services
American Electronic Laboratories	-	command receiver
Bowen-McLaughlin-York	-	M-975 tracked vehicle (GFP)
Brunswick Defense Division	-	booster/sustainer igniter
Ellis & Watts Co.	-	environmental control unit

Eureka Co.	-	missile thermal battery
Fermont Div./Dynamics Corp of America	-	primary power unit
G&H Technology, Inc.	-	umbilical assembly
Goex, Inc.	-	warhead loading
Hazeltine Corp.	-	IFF interrogator
Hercules, Inc.	-	solid propellant
Microwave Associates, Inc.	-	beacon transmitter
Raymond Engineering, Inc.	-	impact fuse
Standard Tool & Die	-	reflector housing
Timex Defense Products Div.	-	gyros
Thiokol Corporation	-	infrared flares
Varian Associates	-	magnetrons[166].

3. Flawed Planning and the Need for Restructuring

a. The U.S. Roland Program Encounters Serious Problems

From the beginning, throughout 1975, the program encountered numerous problems resulting in delays and cost overruns. The problems encountered were primarily a result of the program's unprecedented nature, with the concomitant necessity of a painful learning-by-doing process.

These problem areas involved:

- The U.S. government's role during the license negotiations;
- Insufficient data transferred for the proposal with a resultant overestimation of the system's performance and the maturity of its design;

- The decision(s) to substantially modify the design followed by a major U.S. government policy shift early in the program, with regard to NATO Standardization (i.e., continuing Americanization while maintaining international interchangeability (I^2));
- Underestimation of the task with regard to transfer and conversion of the data package (e.g., design and drawing differences and the conversion of parts, materials and processes), and;
- The inter-related issue of differences between the European and U.S. industrial bases: issues bearing on manufacturing standards and testing in the technology transfer processes, i.e., keeping a TTF&T program from drifting into a DDT&E one.

The first three of the above problem areas is treated in this section of the Roland sub-chapter. These three collectively led to the signature of an inter-governmental MOU and the establishment of associated coordination mechanisms in the fall of 1975 and the program's restructing in early 1976. The last two are covered in each of the following two sections.

As a result of the program's significance and its high visibility, the criticism began to roll in shortly after contract award in early 1975. The program was at the center of much discussion in the American defense community, as well as receiving a great deal of attention in Europe.

At this time most published commentary on the program was highly critical, and it was beginning to seem as though the program might be cancelled. The negative comments originated from a number of sources. In Congress, the delays

and cost overruns created a small storm in the Armed Services Committee's Subcommittee on Research and Development, since it was the substantial savings in money and time, that was the original rationale for picking a foreign system. It began to seem as though the expected savings would only be marginal. In an effort to be candid, the DDR&E produced more ammunition for the critics. There were commonly heard claims that once modifications had been carried out, the U.S. version of the Roland II would be virtually a completely different system from that produced by Euromissile.[167] When Hughes and Boeing announced in mid-1975 that they anticipated that the equipment would not be ready for operational service for five years and four months, the Chairman of the R&D Subcommittee wrote to the Secretary of Defense complaining about the long gestation period and reminded him that the choice of system and procurement approach had been explicitly designed to effect substantial savings.

Unnamed "DoD officials" quoted in the press, also criticized the program. Although the criticism concerning cost overruns and delays were generally valid, the critics were for the most part only marginally informed on the underlying causes. At this time there was a dearth of program publicity that was actually looking at the problems from the longer term viewpoint a great deal of new ground being broken.[168] The confusion was captured in the following quote of Col. Malone,

> Congressional staff members, though aghast at the 5-year 4-month schedule, at the same time called for maximized commonality between U.S. and European versions of the system and procedures which would achieve it. But they said little about how the procedures could be implemented without adding more time. Department of the Army documents offered guidance directed at achieving interchangeability at missile level only, saying nothing about the vehicle or fire control, while OSD guidance suggested going beyond missile level (at no

> cost) by establishing international mechanisms for configuration control. How these mechanisms would be established without cost was unexplained. Interchangeability requirements drive the requisite degree of detail several levels of specification deeper than functional replication of design.[169]

Although there had never been any intention in DoD that the Roland produced in the U.S. would be an exact copy of the original, the issue of the degree of Americanization of the system became a major one after contract award. Even though national standardization and modification of a system does not necessarily exclude a high degree of international interoperability and a high degree of interchangeability, the U.S. government did not initially deal with the international dimension of standardization. This resulted in a storm of criticism from France and the FRG as well, eventually contributing to the major U.S. effort in this area.

Much of the European criticism was predictable. Britain had an axe to grind over the Rapier/Blindfire's having lost the SHORADS competition. The French complained that if the "two-way street" concept was to have any real substance, the system actually should have been bought outright from Euromissile, rather than just the data package and rights. A common German criticism was that the system was no longer really standardized. Though these criticisms were not without merit, the German and French complaints were possibly also due to an inclination to counteract any claims that the Roland II system was not yet ready for production, and Norway's desire to buy the American rather than the original European version of the fire unit.[170]

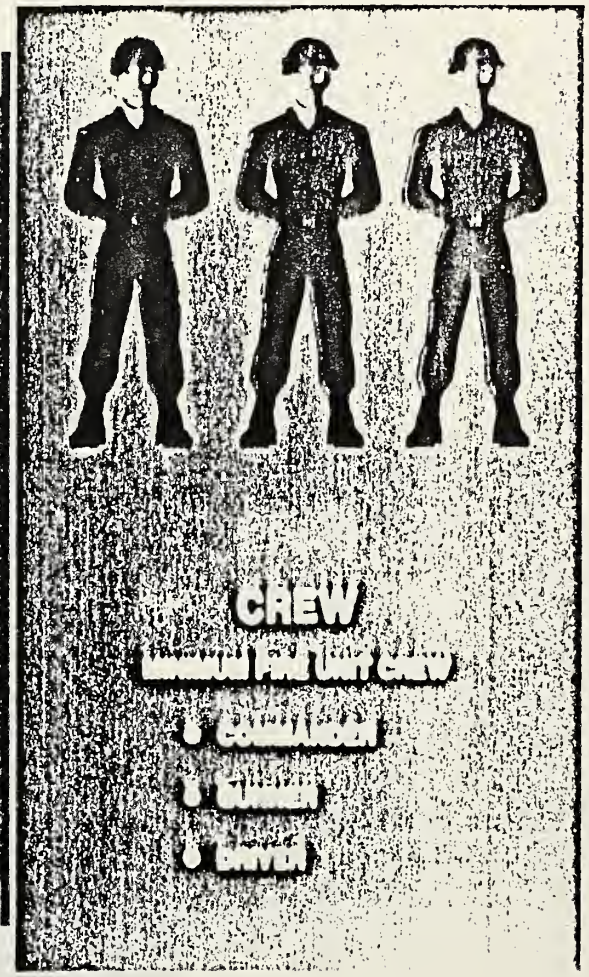
Inherent with the selection of systems tailored to other nations' perceptions of justifiable cost-performance trade-offs, there were also certain operational characteristics of the Roland II that the U.S. Army had to resign itself to living with. This inevitable fact provided ammunition to critics of foreign systems. John Marriott provides us with a major example of this involving the Roland II, in his article in the December 1975-January 1976 issue of NATO's Fifteen Nations; after first covering the Army's dilemna with regard to selection of the vehicle in which the system would be mounted,[171] Marriott pointed out that the Roland also had another feature which was worrying the U.S. Army. Since two missiles are carried on the launcher and eight more in two magazines, the rotating head of the launcher has to be lined up with the fixed magazines in order to reload. If the vehicle can be so sited that the magazines lie in the direction of the attack, there is no difficulty. When the launcher head and magazines are all in one line, Roland's automatic reloading capability works very well. However, if the launcher head has to be swivelled to fire at a target approaching from a different direction, it has to be brought back to line up with the magazines after each pair of rounds have been fired, and this of course takes time.[172] (It must be pointed out, though, that the Roland turret rotates at 90° per second, requiring a maximum of 2 seconds under the worst conditions.)

SYSTEM CHARACTERISTICS

MISSILE



○ LENGTH	2.8 M	○ MANEUVER CAPAB	18 G
○ WEIGHT, RD.	66 KG	○ FUZING	PROX & IMPACT
○ RANGE	6.0 KM	○ STORAGE (CERT. RD.)	5 YEARS
○ FLIGHT TIME	13.0 SEC		



CREW

- Minimum Five Man Crew
- ○ COMMANDER
- ○ GUNNER
- ○ DRIVER

FIRE UNIT



- ○ LENGTH 4.8 M
- ○ WIDTH 2.8 M
- ○ HEIGHT 2.4 M (TRAVEL MODE)
- ○ WEIGHT 11,057 KG
- ○ PAYLOAD 8 ROUNDS
  - 2 IN LAUNCH POSITION
  - 6 IN MAGAZINES
- ○ LAUNCHER POSITIONING
  - 360° AZ, 10° TO 60° EL
- ○ RESUPPLY TIME 8 ROUNDS
  - 10 MINUTES

M812A TRUCK

○ LENGTH	8.3 M
○ HEIGHT	2.6 M
○ WEIGHT	11,210 KG
○ SPEED	89 KM/H
○ RANGE	660 KM

AD 04

b. The U.S. Government's Role in the Industry to Industry Negotiations for a License Agreement

In 1970-71 the U.S. government had signalled U.S. industry to seek out cooperative arrangements with European designers and developers of advanced technology weapon systems. As the SHORADS requirement began to firm up during 1972 and 1973, the original license agreements between U.S. and foreign firms were negotiated on a straight commercial basis.

A DoD contracting framework for a U.S. contractor producing a foreign weapon system under license was non-existent. The DoD was not involved from the beginning. At the time that the licensing agreements were being negotiated, there was no central focal point in the DoD, nor any known policies for U.S. firms acting as licensees of a foreign weapon system. Due to the unprecedented nature of the procurement, the U.S. contractors did not know who to contact nor who was responsible for policy or management. This lack of interagency coordination, during the period when U.S. contractors were negotiating licensing agreements, also took its toll on the competitive bidding process since there had been no clear statement of the DoD's objectives (i.e., vis-a-vis rights and compensation; trade-offs between cost/time and U.S. system specification/requirements versus foreign system capabilities; or the degree of Interoperability or Interchangeability).173

Meanwhile, from another quarter, the U.S. firms were being faced with European concerns over protection of data during the competition, liability arising out

- the requirements for definitive penalty provisions if any partner to the license fails to meet its obligations.[177]

Since problems arose in all of the above due to lack of prior DoD guidance and intergovernmental agreement, some months after the contract award it became necessary for the three governments to negotiate a settlement.[178] The negotiations led to the memorandum of agreement in August 19, 1975, and an MOU on October 8, 1975. The industrial firms involved then spent the next several months placing these new arrangements in final form and negotiating the appropriate amendments to the license agreement, some ten in all.[179] The amended license agreement then had to be approved by the three governments.

"Although it was more difficult to negotiate for additional rights after an original agreement has been reached, as might be expected, neither side was unreasonable and room was found for a mutually acceptable quid pro quo."[180] In any case, the problems were somewhat understandable, in that any comparable demarche in DoD policy is bound to result in a painful learning process as the program develops.

> Each of the license amendments has required that the licensees make payments in some form as a quid pro quo. In certain instances, this has resulted in Hughes and Boeing yielding a right in order to obtain a right demanded by the government. The government has not yielded rights. An example is the amendment which gives the government's support contractor, Sperry Rand, access to the same data as the Roland licensees. As always, data dissemination is a matter of tension with the Europeans. In order to obtain this amendment on behalf of the government, therefore, Hughes and Boeing yielded the right of approval on changes and improvements to the system to be transmitted to Euromissile. Originally, Hughes and Boeing had the right, together with the U.S. government of approving changes. Now the industrial parties have been eliminated from the approval chain. This makes the U.S. procedures symmetrical with the Europeans, in that changes in Europe flow directly with approval of the French and German governments, and do not call for Euromissile approval.[181]

Officials in the U.S. Army's Roland Project Office in Huntsville, Alabama made it clear to the General Research Corporation (GRC) during the latter's investigation of the project that they believed future contractor-to-contractor licenses for weapon systems would require direct governmental supervision and intervention in order to be an effective approach to technology transfer for NATO standardization.

In retrospect, the Roland Project Office would have preferred to have had the Roland license developed in the following sequence: first, negotiate Memoranda of Understanding with each of three nations—the United Kingdom, France and the FRG; then ask the foreign governments to instruct their industries to seek U.S. companies with whom they would negotiate licenses for the purposes of pursuing the Army's missile competition.[182] Given the fundamental conflicts between the interests of the U.S. government and of U.S. industry, the Roland Project Office believed that the interests of the U.S. government could best be protected, and the potential for friction reduced, by means of an MOU between governments negotiated prior to any licensing arrangements. The license agreement can then be properly structured within that framework.

The Project Office added a further argument to support the need for an MOU prior to industry-to-industry negotiations for a license agreement, one which was in good part simply required to offset the unnecessary but typical communication/coordination problems that the U.S. government has in dealing with industry. The Army's Project Office pointed out that U.S. contractors may be placed in an awkward and disadvantageous position in negotiating with their European counterparts, since the latter are very closely tied in with

their own governments. They felt that U.S. industry needed the U.S. government to support licensing negotiations to balance the combined strength of the European government and industry partnerships, as well as representing U.S. governmental interests.

> Most of the amendments were finally negotiated to the satisfaction of the U.S. because the Europeans perceived that they ran the risk of losing the U.S. program altogether if they did not accept statutory and other U.S. restrictions and interests. Loss of the U.S. program would have had a severe second-order effect on their business elsewhere in the world as well as the immediate financial loss of licensing and royalty fees.[183]

Amendment No. 9, which allowed the U.S. Army to procure the system from a second source was reportedly the most difficult to negotiate.

In line with commonly held European suspicions of the vast U.S. industrial complex, Euromissile was extremely reluctant to amend the original license to provide for the possibility of the U.S. Army's procuring the production version of Roland from additional U.S. industrial sources. The concern that the data, as it was distributed throughout U.S. industry, would be used for purposes beyond the limits of the license manifested itself particularly during the negotiations over Amendment No. 9.

> Euromissile was unhappy with the requirement but acquiesced with the proviso that unsuccessful potential second-source offerors would be required to return all data with a certification that they had not and would not use such data for their own purposes. Furthermore, the U.S. government was required to assure that every reasonable step would be taken to protect the data. It should be noted, in this context, that Euromissile rather than the governments of France and Germany owns the data, and is, therefore, privileged to place any restrictions on data release and use that it sees fit and can negotiate, subject only to export controls of the two governments.[184]

There was another provision in Amendment No. 9 on data being made available to potential second-source producers. This could commence after low-rate production was first undertaken by Hughes/Boeing, and once the U.S. government had

notified the French and German governments of its intent to proceed with full-scale serial production of the Roland system.[185]

Many of these problems developed because of the license having been one between U.S. and European firms. A possible alternative often used in Western Europe and elsewhere (and commonly aired with regard to the U.S. Roland program) is the government's negotiating for and procuring the license itself, directly from a foreign firm. If this course were followed, it would be possible for domestic contractors to compete on the basis of this one data package.[186] This however, could involve another even more serious set of problems such as: the general problems of there being no developed U.S. government-foreign industry interface and the difficulty of achieving compatibility between the U.S. government and European firms; the importance of industry-to-industry compatability; and most of all, the U.S. government compromising its buyer position vis-a-vis U.S. industry. On this latter point that of the U.S. government's buyer position, the U.S. government's contractor selection procedure ordinarily involves the issuance of a highly detailed RFP that is meant to bring selection, as much as possible, down to a price competition. If the U.S. government were the licensee, the selected U.S. contractor could continually defer the responsibility for problems cropping up during the technology transfer process back up to the U.S. government by claiming that their original evaluation had been based on the deficient data package that the U.S. government had provided to them.

The following two quotes bear out the difficulty of the choice, and Col. Malone pointed out the drawbacks of both approaches:

> A comparison of the two licensing approaches indicates that a policy whereby the U.S. government acquires the license, then competes a single weapons concept, would force the government developmental agency to manload sufficiently to avoid errors in estimation. However, current manpower policies indicate that sufficient personnel to accommodate such a workload would not be possible. A policy of corporate-to-corporate licensing to form competing U.S.-connected teams is a more facile approach, though it throws the load to the Source Selection process. But there is every reason to believe that it will not satisfactorily put to bed the problems of limited data exchange and limited preaward unfunded project effort. In either case licensing, because it occurs first, determines the nature of the competition in the Source Selection process; that is, one system concept or several.[187]

Moreover, as was emphasized by the fall 1976 version of the General Research Corporation's (GRC) study on NATO Standardization and Licensing, the issues of established working relationships and industry-to-industry compatibility are of no small import.

> Licensing arrangements can be greatly facilitated by the choice of licensee. In mastering problems of the types illustrated by examples discussed in this text, a U.S. licensee will experience more or less difficulty depending on the amount of knowhow it has acquired from working on previous foreign contracts. This suggests that it may be more ecomonical in the long run to select licensees that are already affiliated with foreign licensors than subject the imported item to price-competition in the classic sense. The U.S. should reexamine its policies with respect to encouraging defense contractors to establish working relationships with foreign affiliates.[188]

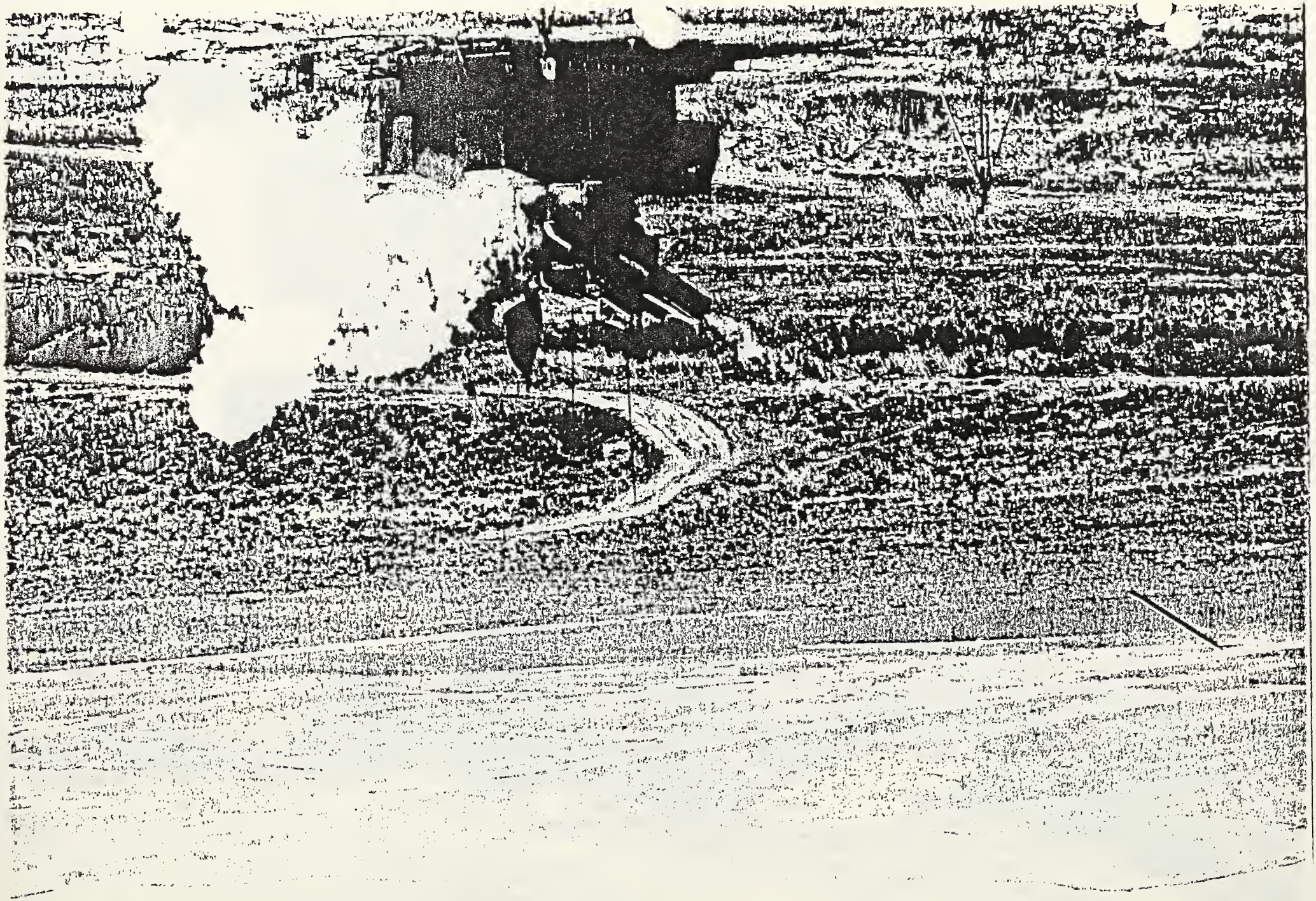
As we saw in Chapter 6 though, with the Italian production of the Boeing Vertol CH-47 Chinook, MOU's are not necessarily useful when the licensee is a foreign firm producing an essentially unmodified design in a less capital intensive industrial environment.

c. Insufficient Transfer of Data During the Competitive Phase, and its Impact on the Proposal

As occurred with such earlier license production projects, as the Hawk SAM system (Chapter 7) and RATAC ground surveillance radar, gaps often arise between the developer's claims and actuality with regards to performance and the maturity of the design. Such was found to be the case for the Roland, as well. Consequently, cost and schedule were seriously impacted.

The concern with the possibility of generating a competitor in a U.S. firm had resulted in the understandable caution on the part of the European licensor, vis-a-vis protecting data during the competitive phase. Accordingly Euromissile provided only enough data to allow the U.S. firms to respond to the request for proposal (RFP), while also being preoccupied with limiting as much as possible the number of U.S. firms and individuals to whom the data could be delivered. On the other hand, however, the U.S. bidders, not being under contract, were not willing to pay an amount for the needed technical data fully commensurate with the value of the data package; one in which the two national governments and their industries had made a considerable investment.

Consequently, the U.S. contractors were not in a position to adequately respond to the SHORADS RFP which contained a system specification with considerable detailed application of normal U.S. requirements. In analyzing the foreign weapon system (all technical data having been received by late 1973), U.S. industry responded by indicating the areas where the system did and did not comply with specifications. Because of the limited transfer of



foreign technology at that stage, Hughes and Boeing in particular were not able to recognize that some of the requirements imposed were beyond the capability of the system without significant redesign.[189]

In order to avoid in future programs the dilemma faced in the U.S. Roland program of compromising system's performance or accepting the cost growth inherent in further development, Hughes' Executive Vice President, John H. Richardson offered several recommendations. First, the U.S. government could provide to the competing U.S. contractors offering a foreign system sufficient funds, as a type of phase zero contract, so as to ensure an adequate transfer of technical data. Secondly the problem of the DoD and the contractor expecting more from a foreign developed system than the system is capable of providing can be in part alleviated if the government would submit the specifications to industry well in advance of the RFP, giving industry adequate time to make a detailed review with its European partners.[190]

d. DoD Policy Shift from National to International Standardization

Once underway, the U.S. Roland program found itself having to shift from a focus that had been the previous rule, national standardization, to a completely new one, international standardization.

The original initiative for the U.S. adoption of a foreign system for its SHORADS requirement stemmed from a policy shift within the DoD, dating from 1970, towards a more rational approach to Alliance R & D that involved an

upgrading of the consideration given to European systems. This program represented a major demarche for the U.S. in favor of rationalizing the use of the Alliance's seriously limited resources by reducing the duplication in the various national technological efforts. The U.S. was finally willing to seriously consider a reversal in the usual direction in the flow of technology and respond to their European allies demands for what was to develop into the catch phrase "two-way street." At last it was recognized that the cause of NATO standardization would not necessarily mean standardization on U.S. equipment. This became especially pertinent by the early 70's as the Continental Europeans began to flex their newly developed muscles, acquired during the build up of their independent national technological bases over the preceding decade.

As became ever more evident during the course of the Roland program, however, rationalization at the R&D level needed to be followed up by rationalization down-stream, where it bears on manufacturing, operation, and logistics support, not just R&D.

As was the case with the Canberra/B-57, the WM/22/MK-87, and RATAC/AN/TPS-25, the original philosophy applied to the Roland system was one of maximizing standardization within the DoD, not at the interallied level. The standardization requirements for defense supply management were the controlling criteria, i.e. to the highest extent practicable, items used throughout the DoD should be standardized. Under this guidance, the January 1975 contract was written to encourage selection of equivalent U.S. parts, assemblies, materials, and finishes to facilitate the establishment of a U.S. production base and permit maximum standardization within the Federal Supply System.[191]

With the case of the U.S. procurement of the Harrier AV-8A off the British production line several years earlier to fulfill through direct purchase a requirement for which no U.S. system existed or was in development, standardization had not been an issue. With the Roland, however, the technology would be transferred for licensed production of the system in the U.S. Even though this was also the original option taken for the Harrier procurement, Congress had balked at the extra cost involved for such a limited number of the planes. The DoD instead purchased the systems directly, while also buying the data package to provide a basis upon which a considerably more advance version of the Harrier, the AV-8B, could be developed for future procurement on a larger scale.

Neither had this been an issue for the other recent foreign procurement, the French RATAC ground surveillance radar. With the RATAC the political, operational, and logistical considerations involving NATO Europe did not play a part in its selection, but a Vietnam War requirement did.

At the time the SHORAD source selection process was underway a DoD policy shift was brewing. In August, 1974, the Nunn Amendment (Section 302 of Public Law 93-365) directed the OSD to assess the costs of the lack of NATO Standardization, to develop and evaluate a list of recommended actions, and then to submit the results to Congress for inclusion in the overall review of foreign policy goals and the development of force plans. At the December 1974 NATO Ministers meeting, the Secretary of Defense made a plea for greater cooperation among national programs to promote NATO RSI. On February 15, 1975, the Office of the Assistant Secretary of Defense for International Security

Affairs (OASD/ISA) and the OASD for Program Analysis and Evaluation sent out a joint memorandum to the Service designed to support NATO RSI.

Meanwhile, of course, the Roland contract had been awarded the previous month and had already been written to ensure maximum feasible standardization within the DoD. An awkward situation was developing for the DoD and the Army. If the DoD's NATO RSI Policy was to have any real meaning, a certain degree of standardization for this highly visible program would be required.

Since international standardization and national standardization often work at cross purposes, the type and degree of standardization present a dilemma for any given program. Through a system of engineering change management controls, however, the interoperability of the systems themselves and a high rate of interchangeability of their subsystems and parts could be maintained.

Still, this new policy probably would not have been implemented retroactively vis-a-vis the U.S. Roland program, with the cost and delay involved, unless it had been for further developments and strong pressures from elsewhere.

e. The Program is Restructured (1976)

The formal program to promote interchangeability between the U.S. and European systems resulted from Congressional interest, fed further by European criticism, in the need to minimize unnecessary "Americanization" of the Roland system in the interest of NATO RSI. This guidance provided the impetus toward a high level of NATO standardization and resulted in a considerable effort to

achieve international interchangeability (I^2). At first, though, there was some reluctance to committing the U.S. to delve fully into the area of I^2.

The MOU of October 1975 between France, the FRG, and the U.S. (signed nine months after contract award) only stated that the three countries would seek an optimum level of standardization and interoperability for their respective Roland systems. Secretary of Defense Rumsfeld reported to Congress that, as a minimum, missile interchangeability (i.e., allowing each system to fire the others' missiles) would be achieved and additional interchangeability would be accomplished wherever it made operational and economic sense. As has been previously stated, the Roland produced in the U.S. had never been intended to be an exact copy of the original. Thus the initial U.S. committment was to achieve I^2 only at the missile round level.[192] But the Europeans expected a greater degree of interchangeability. They continued to press to extend to the U.S. those items which were already interchangeable between the FRG and France. The two European nations reportedly made it clear that U.S. acceptance of the European concept of interchangeability was a necessary condition for continued cooperation between the U.S. and Europe on the Roland program.[193]

By early 1976 a number of additional developments had made a higher degree of interchangeability a more viable option for the U.S. These developments included the U.S. decision to procure manufacturing and maintenance test equipment directly from Europe, and the requirement for an extended joint test program using European test facilities in order to maintain the U.S. program schedule and lower cost.[194] In March 1976, the Army and the DDR&E finally agreed to redirect the program so as to ensure that the TTF&T hardware would

be interchangeable with the European hardware to the maximum extent possible. (This is to be compared with the previous U.S. committment in the MOU in October 1975, for missile/fire unit interoperability only.) At this time, in March, I^2 became the rule. Concurrently the Army initiated a formal program to quantify the benefits and penalities of maintaining interchangeability during production.

In April, 1976, the Army asked Hughes and Boeing to reestimate the program under the new plan for restructuring the TTF&T program. This involved, among other changes, a reduction in the number of fire units from five to four. The proposal was submitted in June for $265 million, some $45 million above the limit set by the U.S. Armed Services Committee in February, but was negotiated within the funds available to the Army by Statement of Work (SOW) adjustment. The new contract (actually Modification 73) was signed in October, 1976 for $183.3 million. This restructuring took into consideration the cost and schedule impact resulting from the technology transfer problems that had become apparent by the middle of 1975 as well as the revised Three Powers Committee Test Program, the I^2 impact, and the effect of the customer's insistence upon "build to print".

The charges of "Americanization" launched at the Project Office since early in the program had stemmed from the considerable concern that funds were being expended on changes to the system, merely to suit the fancy of U.S. designers, for tinkering or just for "changes' sake". Although, as previously pointed out, the Roland system produced in the U.S. was never intended nor expected to be an exact copy of the original, a policy of system interoperability and a

high degree of interchangeability of field replaceable parts was achievable. Not only were the American missiles to be able to be fired from European fire units and vice versa, but, due to the parts selection strategy adopted by the Project Office a very high proportion of the parts in the U.S. and European systems were to be exactly equivalent, which in turn would provide for interchangeability well into the subassembly level.

The optimum level chosen for interchangeability was the level of the field-replaceable units (FRU) or modules, and more than 600 FRUs in the system were identified as candidates for interchangeability between the U.S. and European systems. As of early 1979 the U.S. pursuit of this course of action had resulted in approximately 96 percent of the kinds of parts distributed through the system being interchangeable with those of European manufacture. Once the common list of FRUs was completely negotiated, neither party was to make a change in any item on the list without full coordination with the other. In wartime, this approach would ensure that - with few exceptions - a failed FRU in the system of any national force can be replaced with an FRU from an ally's stockage of parts.[195] The American producers were required to follow a strict "build to print" format, thereby insuring that components didn't deviate in "form, fit, or function".

As for those parts that are not field replaceable it is unnecessary, and perhaps even undesirable, to standardize those components since they can be serviced or replaced only at the factory. The carrier vehicle is not part of the Roland system and therefore is not really relevant to the system's standardization --all three producer nations have followed the path of national standardization in this area.[196]

In the words of Col. Malone,

> The vehicle choice points up one of the dichotomies in NATO standardization. Using a single vehicle for all Roland systems might standardize a low density weapon system among all users, but destandardize each individual nation's fleet.

One major benefit of I^2 was the aforementioned savings in time and money it allowed for in the area of test firings, a capability that the U.S. Army White Sands Test Range wasn't to have until July 1982. Successful test firings of U.S. missiles were able to be conducted in July and again in November/December 1981, utilizing a German fire unit and crew, with France providing the firing range crew, drone, telemetry tracking and data processing equipment. These took place at France's Centre d'Essais en Landes (C.E.L.) on the Bay of Biscay south of Bourdeaux in southwestern France, with U.S. Army, Hughes and Boeing personnel attending.

The lesson provided by the British experience with their Anglicization of the McDonnell Douglas F-4 through its modification to incorporate the Rolls Royce Spey engines and British avionics had borne out amply the costs of excessive modification of a foreign system (treated in Chapter 11, Mode #6 of industrial collaboration). This mistake was not to be repeated for the Roland project. With the exception of several changes in the U.S. version, the U.S. Roland is being reproduced exactly to the European design. The two main changes in the U.S. TTF&T version are: substitution of higher rated rocket motor firing squibs to comply with national safety standards; and the substitution of a higher power transmitter to increase the power output of the track radar for ECCM purposes.[197] A third major change was added for the series production systems, a Hughes designed track radar to replace the Thompson-CSF one.

The NATO Hawk and F-104G projects bear out the basic fact that some degree of variation in the configuration of weapon systems built under license in a foreign country is a common phenomenon. The USAF/Lockheed F-104 light air superiority fighter underwent major modifications in the process of converting it to a multi-role aircraft, the F-104G, in line with the FRG's own military requirements.

The NATO Hawk project had to deal with another problem, that of configuration fluidity of a system in the early stages of production by the licensor, and the need of the licensees to eventually take control by freezing the design and managing any further incorporation of improvements. Following the design freeze in 1964 of the system being produced on an integrated basis in five European nations for a total of seven NATO European governments, it was a full decade before any further changes were incorporated into the NATO configuration.

In the 10-year interim, a considerable gap had developed between the NATO and U.S. Army configurations. Starting in 1968, however, the Europeans did attempt, though unsuccessfully, to introduce their own improvements into the system through the Hawk European Limited Improvement Program (HELIP). The original HELIP concept was abandoned several years later, and the European governments opted to introduce U.S. improvements that had been previously incorporated into the U.S.-produced systems. This has involved two improvement programs, the HELIP (1974-1980) program which involved four technical slices and the Hawk Product Improvement Program (PIP) (1980-1984) for one additional technical slice. The total cost of these two improvement programs have come to over $1 billion.

f. The Organization of the Program Office and the Joint Roland Control Committee (JRCC)

The lack of a prior identification of issues, and the policy to be followed had led to a series of misunderstandings that finally brought the three governments together to negotiate their differeneces and sign an MOU in October 1975, 9 months after contract award. And as already mentioned, further pressures from Congress, France, and the FRG, along with further developments within the DOD, finally resulted in the restructured program being initiated in October 1976.

As we've seen, from the highly ambiguous situation of a totally independent U.S. program in early 1975, things eventually evolved to one where I^2 was realized. This was brought about through intensive management efforts and an organization that recognized the close international cooperation required for the success of this type of program. With the approval of the prior spring, when the restructured program was initiated in October 1976, it was able to benefit from the earlier lessons. The Program Manager, General Ragano, was able to write in 1978:

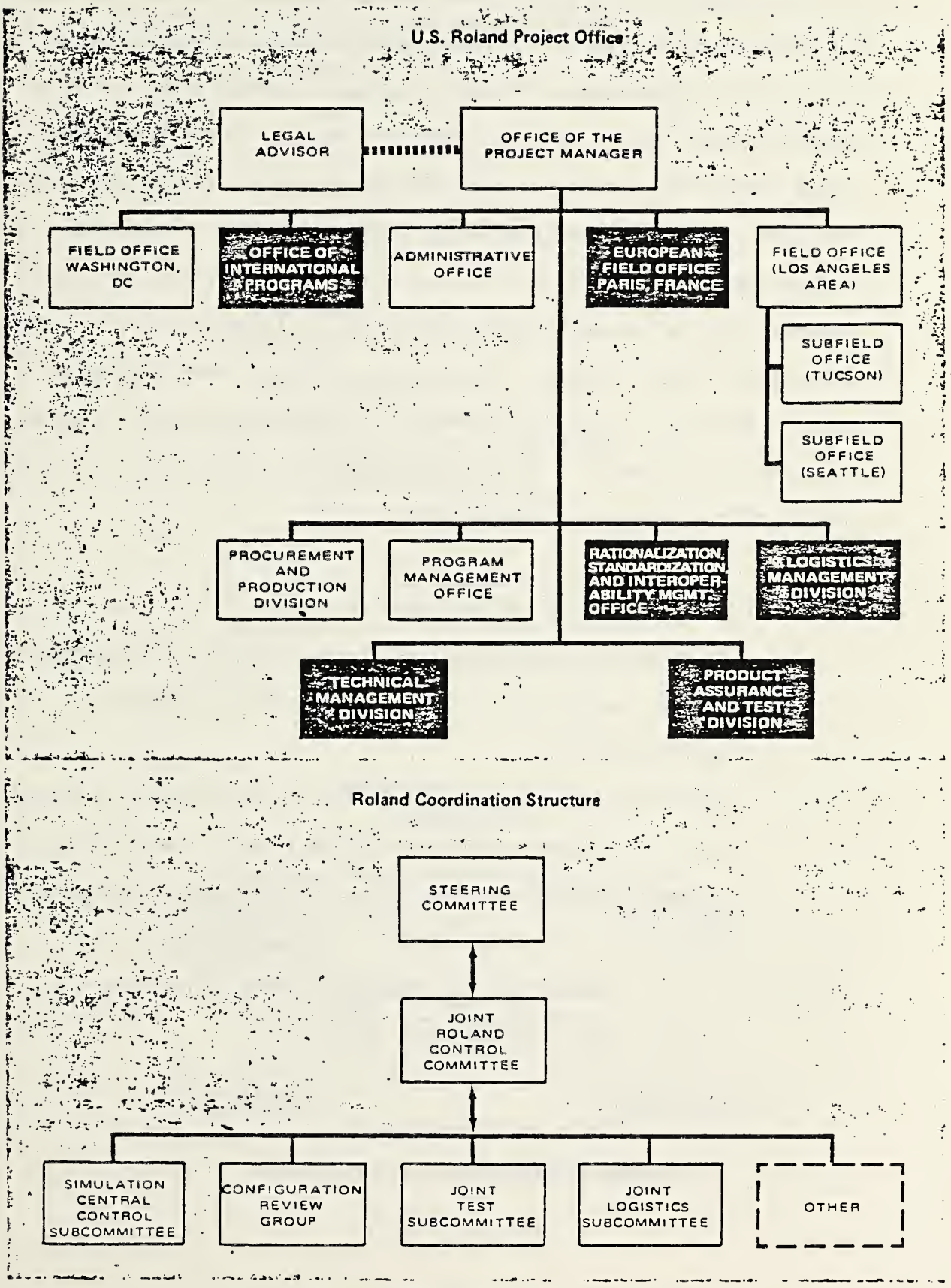
> Communications improved among the various government agencies, major contractors and suppliers. All parties learned to compromise. Some of the normal development surveillance tasks have been recognized as unnecessary, and have been eliminated. A new and comprehensive missile-firing test program has been established jointly with the French and German Armies. The U.S. will benefit from sharing firing ranges, using common data, and most importantly from improved communication and cooperation with our Allies.[198]

The building in the U.S. of a fire unit with its full complement of missiles, within one year of the restructuring of the U.S. Roland program, could not have been accomplished as quickly had there not been a workable I^2 program.

As a result of this I^2 program, the U.S. was able to obtain selected hardware from Europe which was used as a benchmark, saving valuable final assembly, integration, and test time.[199]

One of the other contributing factors that called for greater international coordination on a continuous basis was the initial lack of proper application of engineering change management controls by the co-operating governments. The U.S. Government should have negotiated the overall engineering management control requirements with the cooperating foreign governments, France, and the FRG early in the process. Change controls have to be applied uniformly on the Europoean and U.S. manufacturers. The lack of such control made the timely tracking of engineering changes by the industrial partners very difficult.[200] Another factor brought out early in the program was that in order to obtain the maximum benefit from I^2 a decision on the degree of standardization to be sought must begin with a clear identification of the weapon system requirements by each nation involved. Such items as the differing threat assessments, expected operational scenarios and requirements, and the logistics support required to maintain the deployed system needed to be included.[201]

The resolution of several other problems involving adaptation of standards, manufacturing technology, and technical and performance specifications for the different military services, also contributed to the need for the establishment of a centralized controlling authority to be set up by the governments. These issues are treated in Section 5 of this subchapter.



Source: Defense Management Journal/Ragano

As a consequence of all the above factors, a tri-national control committee was established and the U.S. Roland Project Office was reorganized. The Joint Roland Control Committee (JRCC) was created to address those issues of common interest concerning the Roland system. It was to oversee the cooperative effort and improve the coordination of the U.S. and European programs. It is comprised of the U.S. Army project manager and the French and German government managers for their respective programs, who coordinate the activities of both their respective government offices and civilian contractors. The JRCC, among other things, approves modifications and improvements to each of the national versions in order to provide for strict configuration control and thus maintain a high level of standardization, interoperability and interchangeability between the systems.[202]

The specific objectives of the JRCC were to:

- establish an optimum level of standardization and interoperability;
- increase combat effectiveness by maximizing commonality of logistics and training;[203]
- investigate and implement other activities of mutual interest;[204]
- identify problems affecting both the European and American programs and develop solutions acceptable to participating countries.[205]

The JRCC has joint subcommittees to accomplish these objectives:

- the Joint Test Subcommittee;
- the Joint Logistics Subcommittee;
- the Joint Training Subcommitte;
- the Configuration Review Group;

Functions of the U.S. Roland Project Office

Office of International Programs

- Prepares and coordinates memorandums of understanding and license considerations
- Coordinates activities of:
  - Trilateral Joint Roland Control Committee (JRCC)
  - JRCC subcommittees
  - Translator and interpreter services

Rationalization, Standardization, and Interoperability Management Office

- Manages technology data transfer effort
- Manages international interoperability and standardization

Product Assurance and Test Division

- Administers United States aspects of the Joint Test Program

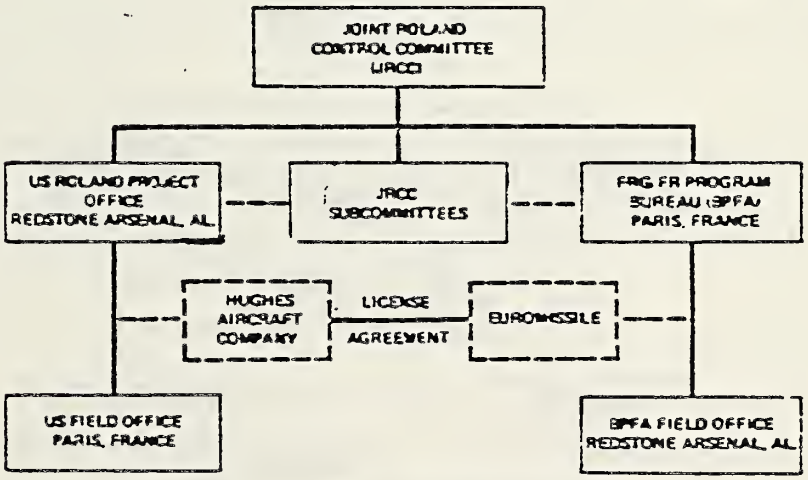
Technical Management Division

- Coordinates such international activities as:
  - Maintaining a common U.S. and European design
  - Jointly improving the system
  - Maintaining a common simulation with European counterparts

European Field Office

- Facilitates exchange of program data and enhances communication

Source: Defense Management Journal/Ragano



US/European ROLAND Coordination Structure

Source: Malone

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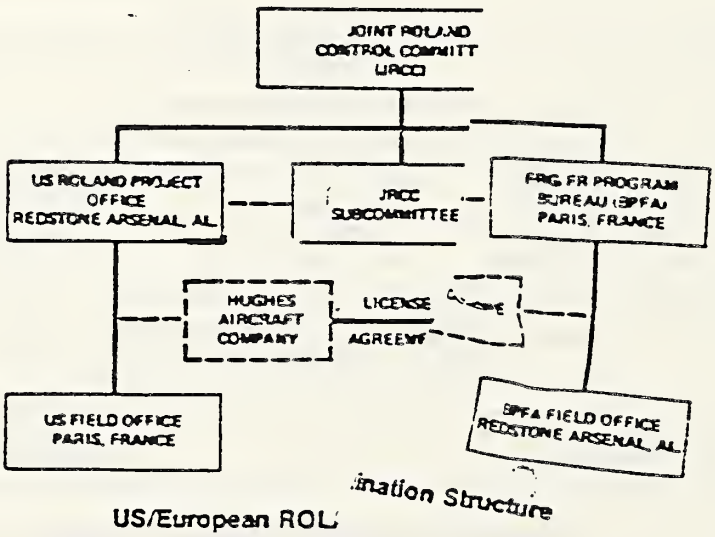
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US/European ROL ination Structure

Source: Malone

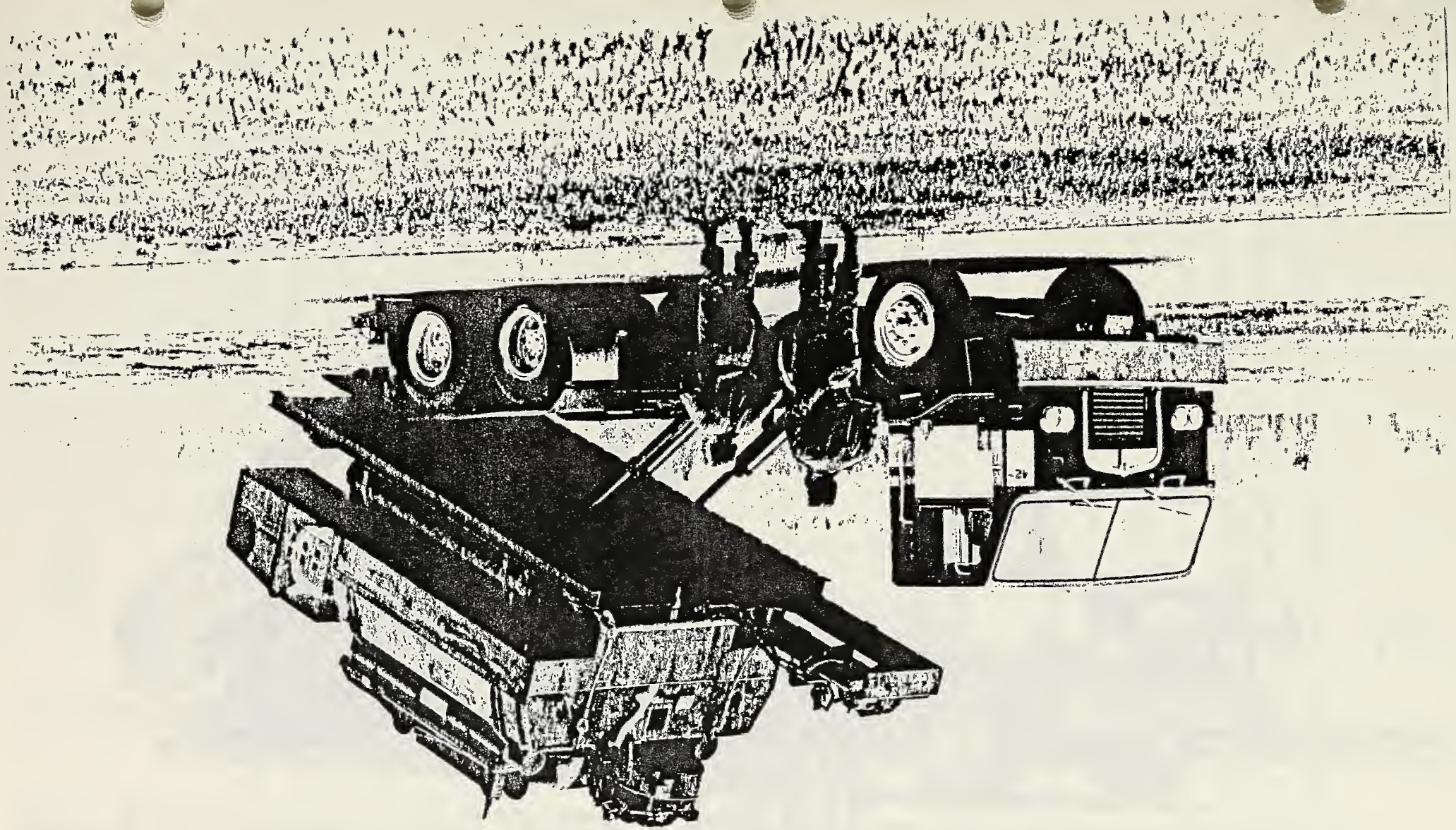
- the Simulation Central Coordination Subcommittee, and
- the Threat Subcommittee.

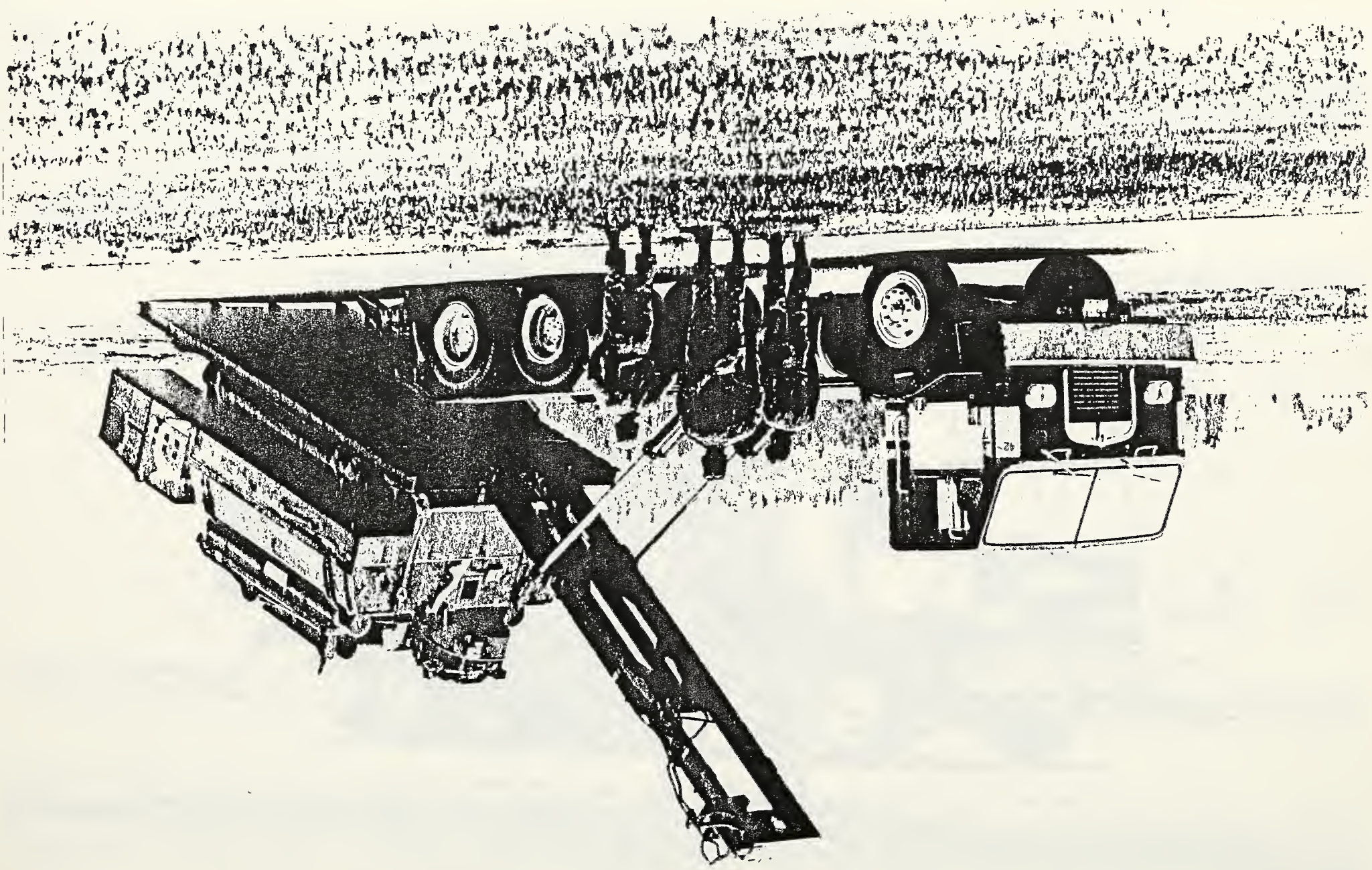
Agreements reached in subcommittee are presented to the JRCC for ratification, while differences unresolved at the subcommittee level are referred to the JRCC for resolution. If resolution cannot be obtained at the JRCC level, differences are elevated to the national armament directors (i.e., USDRE for the U.S. and the DGA for France).[206]

Following the establishment of the SHORADS Project Management Office back in February 1974, the first Program Manager, Colonel Hank Magill and Mr. Edward Dobbins, his deputy, exercised selectivity in hiring people, trading time for quality to assure the right mix of abilities to handle the novel task before them. But in October 1974 they were caught in an Army-wide hiring freeze which left the Project Management Office (PMO), at the time the contract was finally awarded in January 1975, with no more than 31 of the authorized 61 people. Making do in the interim with temporary detail (120 days under Civil Service Commission Regulations), it was June 1975 before the freeze was lifted and by June 1976,

> ... the personnel authorization had expanded to 106 civilian and 17 military personnel. Moreover, the quality of staffing had by then greatly improved and was reflected in a competent, hard-working military and civil service project management team, who took pride in their unique role in NATO weapons management.[207]

For the organizing of a project office to manage such a program in the future, the second U.S. Roland Program Manager, General Frank Rogano, later emphasized two points that he felt needed to be kept in mind, involving the number and skill of personnel and the additional functions required.[208]

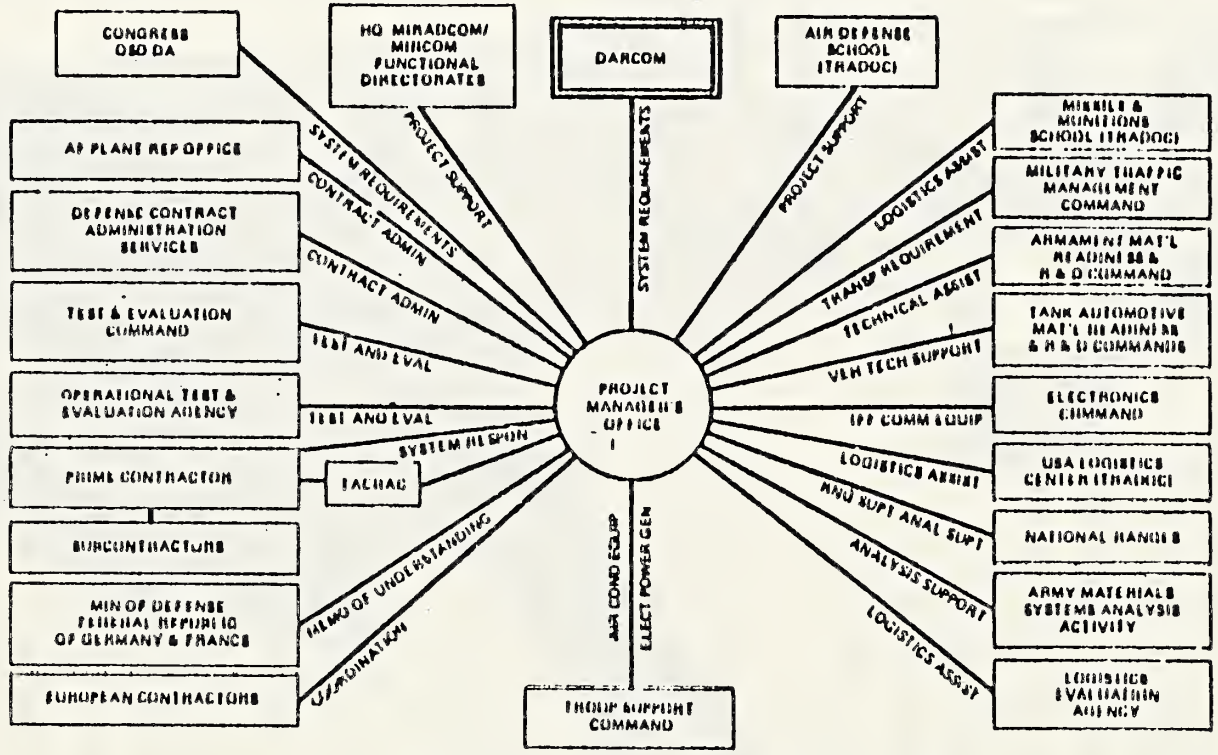




A project organization involved in technology transfer, as well as international interoperability and interchangeability, must have the personnel to accomplish its additional responsibilities. According to Gen. Ragano, a project such a U.S. Roland requires an estimated 50 to 60 percent increase in manning levels over a domestic program of comparable complexity. Gen. Ragano also considered one of the lessons learned from the program to be the need for established personnel regulations to be utilized with the understanding that they do not provide for consideration of the unique nature of international project management activities - staffing a project office to conduct an international program with the proper skill levels, being difficult even under optimum conditions.[209]

The functions that needed to be added to the Roland project office's organizational structure as a result of international involvement are shown on the following chart as the shaded blocks. The subsequent figure explains the functions performed by these key offices. Additionally, a U.S. field office was established in Paris, France colocated with the Franco-German Program Office.

Once an organizational structure to manage the U.S. Roland project was established and a contract was signed with the manufacturer, an effort was initiated to resolve differences in requirements and design between the U.S. and European systems. One of the JRCC subcommittees, the Configuration Review Group, was charged with establishing both an optimum level of interchangeability and the mechanisms for maintaining it as well as maximizing hardware standardization between the two systems.[210]



Organizational Interfaces for Management of ROLAND II

Source: Malone

By the spring 1978, 17 of the identified 20 potential requirements and design differences had been resolved by the establishment of a common requirement or design, and the Group was still working toward resolution of the remaining differences. In the case of several of these potential differences, they were in reality only distinctions in the manner of expressing requirements rather than specific differences in performance. As an example of more substantive differences resolved by compromise, the Roland is powered by a 50 hertz primary power unit, as opposed to a 60 hertz unit that was originally required for the U.S. Roland. If the U.S. had prevailed with the 60 hertz unit, several system hardware items, such as fan motors and timing devices, would have required change due to the frequency difference. In order to avoid this, the U.S. Roland primary power requirement was revised to 50 hertz.[211]

Strict procedures established for the receipt, control, translation and conversion of European data also enhanced design commonality.

The contract for the restructured program requires the U.S. contractors, Hughes and Boeing, to report monthly on changes to the I^2 list, which must be negotiated with the two European partners. Although the present Roland II has potential for growth and improvement in the areas of guidance, aerodynamics and propulsion, any such changes must be approved by the JRCC.[212]

One further point mentioned by Gen. Ragano as a lesson learned from the program which is relevant to the task of the JRCC, is the importance of precise wording being used in MOU's. "Vague or ambiguous phraseology can result in subsequent misunderstandings. All parties to an MOU must be aware of its

obligations, and positive action must be taken to prevent violation of its terms."[213]

4. The Transfer and Conversion of the Data Package

Technical data transfer problems that had begun with the limited data package from which the U.S. contractors had to respond to the RFP continued upon contract award.

In addition to the overestimation of the maturity of the system covered previously, both the Army Missile Command and Hughes/Boeing underestimated the effort involved in technology transfer. In the words of Colonel Daniel M. Malone, "It was simply a mistake." Moreover, as further explained by Col. Malone,

> ...in the government case at least, virtually all the people involved in the initial evaluations were from R&D laboratories or R&D-related offices.
>
> R&D people earn their paychecks by learning to live with the light at the end of the tunnel. In terms of personality and training the seemingly monotonous task of developing detailed drawings, data, and procedures necessary to replicate a technical component, in production quantities, at least cost, takes second place. In general, the farther one goes from the production shop floor, the less the realization of the size and scope of the engineering task; thus, in the halls of the Pentagon and the Capitol, there was great dismay at the enormity of the undertaking. The estimated 25,000 documents to be transferred turned out to top the 100,000 mark.[214]

Mr. C. G. King, the original Boeing program manager, provided the following figures at an American Defense Preparedness Association (ADPA) meeting:

Developing a usable Technical Data Package (TDP) required translation or conversion of 22,000 drawings, 4,000 specifications, 33,000 tooling, manufacturing, and bench test/evaluation plans, 7,000 standards, and 49,000 engineering change orders, revisions, and updates at a total cost of about $18 million.

Historically, there has been considerable experience with the successful transfer of technology of U.S. weapon systems to Europe for licensed production. The MAP off-shore procurement contracts of the early and mid 1950s had a significant technical impact - many European firms having learned to work with American drawings, production methods, and technical personnel. This was continued as the European governments increasingly picked up the cost of their own arms procurement, with the national and multinational production of U.S. weapon systems after the late 50's, first under license and later as subcontractors. On the other hand, know-how accumulated through any experience with the transfer of technology for the licensed production on a large scale of a major weapon system in the reverse direction, especially while also maintaining a high degree of standardization/interchangeability, was very limited. The U.S. Roland program therefore found itself at the center of a learning process vis-a-vis the mechanics of technology transfer from European to U.S. firms, be it one that also involved a certain amount of relearning of the lessons provided by similar earlier projects falling within Mode #4 of industrial collaboration.

a. Producibility

Producibility was undoubtedly one of the most important problem areas of the Roland program. Having over-estimated the systems maturity neither the European nor the American governments or industries fully appreciated the problems involved in making the Roland II prototype a producible weapon system. On the basis of the data initially made available to them for their response to the RFP, the U.S. team assumed that the Roland was a mature system, ready for production, but this was in fact not so. Only after the Roland was selected and Euromissile freed additional data was it discovered how much was missing. This is to say that the Roland II system was fully developed but was not yet producible. Further European modifications to the developed prototype missile for producibility adversely impacted the system performance capability at a time when the technology was being transferred to the U.S. contractors.

Such producibility problems are not unusual in the transnational licensed production of advanced weapons systems, or for purely national programs, for that matter. The high uncertainty factor involved in the development of complex weapon systems can be hedged against, but not avoided. One of the principal lessons learned of the NATO Hawk and the F-104G Starfighter programs in the early 1960s was just this: there is a vital difference between the licensed production of an existing, proven weapon system and one that is developed but not yet producible or still only in the early stages of production. Neither is the international context a necessary ingredient for this problem to arise. The complexity, however, is compounded when three governments and three national industries are concurrenty involved in the process. Resultant schedule delays and cost increases cannot be avoided.

The fact that the Roland II design was not totally stabilized had a significant impact on both drawing conversion and the fabrication process. The system was just entering low rate European production when the U.S. Army began its TTF&T program, a phase in the life cycle of a system when the developing contractors inevitably were processing numerous changes. This was particularly true in the case of the track radar, in which case an almost complete set of new drawings was received after the technology transfer had begun.

b. Transfer of Drawings and Documentation

The licensing agreement had unrealistically scheduled the delivery of all European drawings on microfilm cards, following contract award, to the central focal point for incoming data at Hughes. However, since only a few drawings were on microfilm at the time the contract was let, most deliveries of technical data could not be in line with the initially required program milestones. The definition file, or 'dossier de definition initiale,' for the fire unit and missile consisted of some 25,000 drawings and 23,000 documents. In addition to the documents delivered as part of the definition file, another 36,000 European documents trickled in over the next several years that were not part of the system's technical data package. On top of the four months to accumulate, photograph, document, and transport this data package, an additional month was required which included customs, reproducing contents for translation, assigning Army part numbers to each drawing, cataloguing and distributing items to the project engineering activities.[215]

Many of the data problems that were encountered after receipt of the definition file resulted from the fact that many items of data that the contractor expected to receive as part of the European documentation were, in fact, not furnished. A certain amount of this is inevitable in any technology transfer program, although some of the problem stemmed from the European firms not being as systematic as their American counterparts in documentation. In all fairness, though, as emphasized by BAC's U.S. Roland Configuration Control Manager, Gerry Magness, upon closer investigation it was found that much of the data that was originally thought to be missing was in fact there. It was often just a matter of greater familiarization with the European documentation which of course does take time.

The difference in approaches to documentation stemmed from the differing labor environments, i.e., the longer term nature of European employment where, with lower turnover rates, much of the data can remain tucked away in the employees heads, pockets, or desks. Examples of documentation expected but not furnished included:

- system operational procedures;
- survivability and electromagnetic compatibility analyses;[216]
- human factors and training data;
- detailed fabrication and test specifications;[217]
- production planning including tooling,[218] test equipment, and test setups;
- documented environmental, reliability and availability test data.

The gaps in system knowledge represented by these data shortages required that the American contractors initiate independent engineering analyses to produce the necessary specifications and documentation.[219]

c. Translation

Whereas, translation of the notes on drawings was performed in-house by Hughes and Boeing, a specialty company provided translation services for documentation, catalogues, manuals and similar textual material. Translation was originally of such concern in terms of quantity and quality that Hughes had considered preparing a large technical dictionary. Instead, a translation company, Agnew Tech-Tran Inc., was awarded a $321,250 contract to translate data from French and German into English - and with good results. Strict quality control was easy to implement and translation anomolies were quickly fed back to the contractor, with a high quality translation product resulting.

As for the translation required for working with functional counterparts in the other firms, Lydia Pickup of Boeing drew from her experience in configuration management in providing the following example of the not unusual problem of the gap between the "language" of a technical field and literal translation during the Roland project.

> In defining the methods used in each country, in identifying the differences, and in determining the solutions to problems caused by these differences, it is important to recognize that literal translations may cause more problems than the actual methods do. For example, after several meetings among representatives of two U.S. companies and three European companies, there seems to be no better common understanding of configuration management methods than there was before any of the meetings were held. In preparation for yet another meeting, I was asked to prepare viewfoil charts showing how we controlled changes, how the other U.S. company controlled

changes, and how the European companies controlled changes to see if perhaps a review of all three might provide a common understanding. The two U.S. companies' charts, although a little different, were no problem, and I was to use a European chart from a translated document—and there was the key to the whole thing! That chart happened to have been prepared originally in French and showed both the French and the literal English translation for each item on it, and the literal translation of the French words bore no relationship to the comparable U.S. terminology for the same activities. Now, as many of you know, my knowledge of French is very limited, but even that limited knowledge, coupled with my thorough understanding of configuration management, let me prepare a chart of the European methods showing our configuration management terminology along with the French words from the original chart, and all at once we had the beginnings of a common understanding which let us all move on to identifying the differences and determining solutions acceptable to all parties. The "secret" to success in communicating lies in applying a knowledge of the field and recognizing when a literal translation is not the answer. It is well worth the time and effort to teach at least the rudiments of the field to the translators or to have them work closely with those most knowledgeable in the field so as to come up with the best translation possible. We must all use our imagination and ingenuity to determine what is meant by the words used.[220]

In his monograph Roland: A Case For or Against NATO Standardization?, Col. D. K. Malone covered, in a chapter entitled "A Historical Retrospect," the U.S. experience during 1917 and 1918 with the transfer of the technology of the French 75mm field piece for the manufacture of both the gun and its ammunition in the U.S. After a comparison of the two projects and the many similarities of their two experiences, Col. Malone brought out three major areas of differences — standards, metrification and language — the first two of which having reversed themselves in significance with the latter over the intervening 60 year period.

There are, of course, many differences between today's level of ability to achieve international standardization and the ability present in 1917. Recognized standards for taps, dies, and performance specifications, for example, have emerged, impelled particularly by the burgeoning automotive industry which was then in its

> infancy. Those basic systems are just the beginning of a long list of standards now internationally in use. But some problems have been exchanged for others: metrification, so difficult for the French 75, was not difficult at all for Roland, and Dickinson, in his Ordnance Corps report, used sentences in French which he did not bother to translate— presumably, any American in a position to read his report read French. The two problems today have exchanged places.[221]

Col. Malone, further emphasized the inadequacy of the current state of affairs in American foreign language skills.

> Having grown accustomed to using English from coast to coast, Americans tend to neglect the study of other languages. Indeed, language study is decreasing in the schools at a time when expanding international relationships, such as with NATO, heighten the need for Americans to have foreign language skills. Not only American colleges and universities, but the U.S. Army as well, need to place an increased emphasis on foreign language study.[222]

d. Design Differences and the Lack of Drawing Convention Standards Impact Conversion

Even though the linework of the original European drawings was reproduced photographically, with only French and German legends translated into English, there were problems that had to be overcome. The unexpected lack of a high degree of standardization in European design and drafting practices meant that each of the Roland's 14 major contractors in France, FRG and Belgium had its own drafting practices. For example there is no consistency in circuit design criteria. Each circuit designer apparently used his own design criteria for component derating, selection in test components, lay-out of P.C. boards, internal box wiring, mounting and spacing of parts on P.C. boards.

One commonly cited example of European drafting practices differing from the American was already cited in the Canberra/B-57 project history, European industries' use of first-angle projections rather than the third-angle projections in use in the United States, which means that the two are 180 degrees out of phase with each other.

It was originally assumed that there were European counterparts to the U.S. drawing convention standards (i.e., MIL-D-100 and MIL-D-1000) where all U.S. contractors follow the DoD drawing norms as to how drawings are to be made, and the quality requirements to be maintained. This proved to be a mistake. Not only were there no equivalent standards, but in Europe far more dependence is placed on the craftsman's know-how. Consequently, drawings often lacked details which are part of our standard drawing practices.

Europe's guild tradition, with its greater reliance on craftsmanship, therefore had a major impact on the technology transfer. Many shop bench-practices were not explicitly defined in the technical data package as in U.S. practice.

> Measures and measurements often had to be tediously derived from functional descriptions. Converting some of the drawings consumed four times more effort than anticipated. No single difference was overpoweringly difficult, but the total resolution of Roland's technology transfer demanded more time, money, and skilled manhours than anticipated.[223]

The drawing transfer task required the U.S. contractors to acquire most of the drafting room manuals from each European contractor and subcontractor to permit conversion. For future programs, Richardson recommended that European drafting room supervisors spend from two weeks to a month at the U.S. con-

tractor's facilities to review the European drawings and documentation and enable a more rapid and efficient conversion to U.S. drawing practices.[224]

In addition, instead of a drawing indenturing system like the U.S. system (as required per MIL-D-1000), each European subcontractor had its own system of numbering and annotating drawings. In many instances callouts on the drawings were references to a commercial catalogue that had to be obtained and researched. The end result was that the U.S. contractors had to generate an indentured drawing list to understand the interrelationship among all of the drawings and documents received.[225]

e. Configuration Management

Technology transfer involves more than simply assuring delivery of the drawings to the licensee. This was borne out by the Canberra, WM/22 (both being Mode #4 of industrial collaboration) and NATO Hawk (Mode #2) experiences where drawings arrived in unorganized bundles with their inter-relationships unclear, and many of which were out of date.

The discipline of configuration management offers among other things, a method for controlling changes that prevents any one of the manufacturers involved in the various segments of the system from working in isolation, making whatever design changes it wishes without regard for its impact on the rest of the system. When a change is proposed, a complete definition of its impact on the rest of the system is required along with a listing of the drawings and documents which would have to be revised. One relies on the list of documentation

to be revised and on the number assigned to the change in the revision description of each drawing and document to allow the "users" to determine when that change has been incorporated into each item of documentation and when all required documentation revisions have been made so that they can proceed with the fabrication and testing of each piece of the system, knowing that a fully coordinated change is ready for implementation.[226]

As pointed out by Lydia Pickup, for the U.S. Roland it was soon discovered by the U.S. contractors that when they received a package of revised documentation and the change notice which listed the drawings and documents, the chances were excellent that these revisions were parts of a number of unrelated changes and that the change notice was simply a listing of whatever drawings and documents happened to have any change incorporated at that time. This meant that for each drawing revision there was no easy way to determine whether that change affected that drawing only or whether there were many drawings affected, all of which were needed in order to build a total working system.[227]

Since these drawing changes were not uniquely identifed by a "change number," they had to be researched to establish a change history. Though not an insurmountable problem, it did take additional engineering time to define when all revised drawings for each change had been received, rather than permitting easy configuration accountability by lesser trained personnel based on a change notice which listed all required revisions for one change.[228] It also caused additional time and money to be spent on communications between countries both by mail and by telephone in order to sort out some of the confusion.

However, as Gerry Magness, Boeing's U.S. Roland Configuration Control Manager from 1974-1983 emphasized, once the Europeans established their production baseline, firm configuration management disciplines were implemented throughout the European ROLAND companies. This eliminated the problems discussed above, especially after complete change packages were supplied to the U.S.[229]

But then not all changes to the European design actually need to be incorporated. For example, some changes are made to facilitate fabrication due to the manufacturing techniques used in the manufacturers' plants. Often, this kind of change will not be beneficial in both countries and therefore would not be incorporated in both sets of drawings. When such a change is not incorporated, care must be exercised on all subsequent changes to the same drawing to ensure that omission of that one change remains both desireable and feasible, or that it is later incorporated and accounted for.[230]

In her paper covering her Roland project experiences in the area, Lydia Pickup provided the following suggestions with regard to configuration management.

There are several main steps to be followed in order to provide Configuration Management during technology transfer:

1. Ensure that each understands the other's existing methods; identify any problems which the other's methods will cause; and find mutually acceptable solutions to those problems.

2. Ensure a complete exchange of drawings and documents and of all changes thereto, and provide strict accountability of all such items received or sent.

3. Provide a complete definition of each change, including a listing of all affected drawings and documents and a schedule of when each revision will be complete; assess each other's changes to determine whether or not they must be incorporated; and provide a feedback of this decision into the "received" accountability records.

4. Ensure that the applicable change number is identified in each drawing and document revision description and in the accountability records, with the records reflecting actual incorporation, as well as scheduled.

5. If interchangeability is required, a careful determination of the level of interchangeability must be made and controls imposed to ensure adherence to that decision.

Miss Pickup concluded by reminding us that the key to each of these steps lies in the translation from the language of one country to that of the other, with the "language" of the field superimposed on the literal translation. Key words and phrases can be taught to non-bilingual personnel who need to provide accountability prior to translation, and translators can be taught the rudiments of the field and given ready access to experienced personnel to ensure proper translation. "This sounds fairly simple—and it really is, provided those working the problem are capable of exercising and willing to exercise

imagination and ingenuity in finding solutions which will be acceptable to all parties."

"It is important to remember that configuration management is a discipline, and requires a disciplined approach to identification, control, and accountability for whatever technology is being transferred from one country to another."

f. The Selection/Conversion of Parts, Materials and Processes

A parts, materials, and processes selection strategy was firmly established for the U.S. Roland program that furthered the maintenance of design commonality between the European and U.S. Roland II systems. The Project Office felt that this was one of the major keys to a successful technology transfer program. The Office's intent was to retain the technical integrity of the system. Their aim being to transfer the European design intact. The Office repeatedly stated that there was no desire to "Americanize" the system.[231]

The original objective of the Roland program, and one written into the contract, had been to have all materials and parts produced in the U.S. The RFP required the contractors to identify U.S. suppliers for all components. The original plan was that there would be no critical SHORADS components procured off- shore.[232] This, however, had to be rapidly abandoned.

Ordinarily, as a licensee gears up towards a higher percentage of manufacturing content of components and subsystems of a high technology system, it

moves forward gradually phasing out in a series of steps (or technical slices) the percentage of items purchased from the licensor(s). Even considering the DoD policy of avoiding dependence on extra-continental sources, and in such a case as this one, where it is a basically a know-how license and the licensees are not constrained by a limited technology absorption capacity, it is highly questionable whether this 100 percent U.S. source goal is ever worth the cost.

This is especially important when only a few systems are being fabricated as during TTF&T, and in those cases where no equivalent part exists in the U.S., or where the tooling costs involved are too high to be amortized over the production quantities. As a program butts against these problems, it finds itself rapidly confronted with every diminishing marginal returns.

In any event, the goal of transferring the European design intact and minimizing Americanization was realized by the Project Office. Strict controls were set up for the approval of parts selected for the U.S. Roland. Each European part was screened to determine a U.S. counterpart. Parts were selected from European catalogues, parts which had qualified to standards such as Deutsche Industrie Normen (DIN), Normenstelle Luftfahrt, or Norme Francaise[233] (NF). If an exact U.S. equivalent could not be found, then a nearly equivalent part was selected, subject to approval by the U.S. Roland Project Office on a case-by-case basis.

Despite the high level of equivalence, or near equivalence, in parts eventually obtained, the U.S. contractors encountered considerable difficulty in the conversion of electrical and mechanical parts from European to U.S. parts.

At that time there were only very limited European-to-U.S. parts conversion lists. Without the lists it was necessary to obtain an in-depth understanding of each part so as to assure proper conversion. The effort needed for conversion of the greater than 17,000 different type parts required significant time and resources. In spite of these problems however, 99 percent of all parts conversions were made during the first 9 months of the program.

Lists of parts applicable to such programs have been in the process of being developed by a NATO Working Group for several years, and when these are completed the parts conversion task for future programs will be greatly simplified.

The U.S. counterpart search was conducted using the Army Data Retrieval Engineering System (ADRES) which, "as the U.S. Roland project shifted into high gear, improved the correlation of U.S. MILSTD parts, commercial equivalents, or approximations to those of Euromissile."[234] However here too, there was an underestimation of the effort required. The original estimate of 90 percent correlation between Euromissile's parts and available U.S. MILSPEC/MILSTD counterparts for a total number of 68,230 parts, turned out to be only 60 percent. (i.e. excluding the vehicle and communications equipment, subsystems for which national standardization is the norm).[235] Of the total number of parts cited:

- 54,800 are exactly equivalent U.S. parts;
- roughly 4,000 are nearly equivalent U.S. parts, and;
- 9,430 are European-purchased parts.

As for European-purchased parts it was planned that most of them would eventually be procured from U.S. sources. A major exception however, would be electrical connectors.

Among the 2,500 electrical connectors in the system, 1,300 are associated with U.S. peculiar items and are therefore not required to be interchangeable. Of the 1,200 other connectors, all will be interchangeable with those in the European fire unit. 800 of these are already common because France and the FRG use some U.S. commercial connectors. The 400 remaining connectors are unique to Europe and are not available in the U.S. Since the estimated cost of tooling for production was too high, it was decided that these would be procured by the U.S. off-shore and stockpiled to reduce U.S. Army dependence on the European production base.[236]

The remaining 8,720 parts (US MIL STD) are of U.S. origin. These are in the vehicle module, the prime power and environmental control units, and the tracking radar transmitter. The vehicle module is unique, being a specially modified GFE M975 vehicle. (The Europeans integrate the fire unit directly into their respective national vehicles.) Related to this modular approach adopted by U.S. Army with regards to the fire unit and vehicle, prime power and environmental control units had to be developed for the U.S. fire unit to replace the corresponding integrated European subsystems. Finally, the tracking radar transmitter is a different design from that of the Europeans, resulting from a more stringent U.S. assessment of the electronic countermeasures (ECM) environment posed by the Warsaw Pact. The U.S. track radar transmitter has higher power and cooling requirements than the European one.

The French and German armies expressed interest in this higher-powered version being developed in the United States.[237]

There will be one further change in the system from the original European design that has led to allegations of "Americanizing" the system. When the U.S. Army conducted a preliminary evaluation of Roland and other foreign systems in 1973, it recommended to the developers that the analog command computer be replaced by a digital computer. The developers concurred in this evaluation, and series production Roland II's have a digital command computer designed by MBB for the European line and by BAC for the U.S. line. In the meantime, the U.S. Army had selected Roland with a caveat on the computer and accepted the first four TTF&T fire units with AEG-Telefunken analog computers procured from Euromissile. This case led to further complaints that American engineers had redesigned the computer system for Roland, being cited from early in the program as an example of the excessive Americanization of the system.[238]

Several examples of comparisons that impacted on parts selection, stem from the fact that in Europe:

- Far more commercial parts (versus MIL-STD parts) are used;[239]

- Parts are not derated to our normal derating standards (50 percent voltage, etc.);

- There is a greater utilization of discretely selected parts;

- Circuit breakers are used to perform switching functions;

- Far more 'select-in-test' components and/or potentiometers are used, and;

- Carbon composition resistors with ± 5% tolerance are used in some sensitive circuits.[240]

Furthermore, as pointed out by Col. Malone vis-a-vis parts selection, HI-REL parts, and the build-to-print approach to replication,

> At the piece-part level, the significance of choosing between the "Chinese copy" and a "build to print" copy becomes more clear. The former would demand an exact copy of parts and their location in the U.S. product. The "build to print" approach allows much more leeway in selecting parts, and in relocating parts to accommodate particular assembly tools or procedures familiar to U.S. workers, and would thus be less expensive. Much of the argument insisting that HIREL parts are an expensive "Americanization" loses its cogency when the more serious considerations of choosing connectors, and other unavailable parts and processes for "build to print," or making a "Chinese copy" are introduced. But in any case the major technology transfer cost did not accrue from deciding on HIREL parts, even though their use in many cases required relaying some printed circuit cards; that is rearranging the "wiring" and connections on the card, to accommodate the larger size of most HIREL parts.[241]

The NATO Hawk Program, treated in Chapter 7, had to backup and make this same distinction between a "chinese copy" and "build-to-print", once the program was already underway.

The conversion problems experienced with parts was not as great for materials and processes. Generally, most materials specified in the European drawings are available in the U.S. and most manufacturing processes specified in Europe

have been derived from U.S. MIL STD processes. Approximately 93 percent of the U.S. materials and processes were exactly equivalent to their European counterparts.

Although conversion from a European to a corresponding U.S. process was a direct task in most cases, there were a few cases where considerable effort was required because of European reliance on highly skilled artisan type labor. These problems are treated in the following section. Again this can be contrasted with U.S. processes which don't rely as heavily on the skill of the laborer.

In spite of all these complications encountered in the transfer and conversion of the technology, the U.S. contractors were able to release for manufacture 93 percent of the total technical data package 14 months into the program. No small achievement.

5. The European and U.S. Industrial Bases and Issues Bearing on Manufacturing Technology, Standards, and Testing in the Technology Transfer Process

(Americanization, the need for, and the extent to which it is required)

Interrelated with the previously mentioned changes made in the U.S. Roland and the relative equivalency of parts, materials and processes, the issue of Americanization also involves more subtle differences based on the need to assure the system's conformance with current U.S. manufacturing technology. This involves primarily a difference in the continuity and scale of the individual national defense technology efforts, which impacts on approaches to production, and then in turn the requirement for additional testing.

The fit of technology developed in one national industrial environment into that of another national environment generally requires a certain amount of adaptation. The degree to which a special fitting is required for a given transfer is inevitably a function of the two national industries involved.

In the words of Col. Malone,

> Each industrial nation has developed within its own infrastructure sets of standards and measures which pervade its engineering design. In U.S. defense industries a set of Military Specifications (MIL-SPECS), Military Standards (MILSTDS), for parts and processes, and qualifications for high reliability (HIREL) parts has evolved to a high state of perfection. MILSPEC/MILSTD parts are required with few exceptions in designing all military equipment. Sad experience led to the imposition of a requirement for HIREL parts in missile applications by documents carrying the weight of law. High reliability parts, manufactured to more precise standards, subjected to more quality control, and built sturdier for more robust performance than normal parts are, of course, more expensive. Their use, however, prevents a million-dollar missile from aborting because of a failed 50-cent electrical connector.[242]

For desirable military, economic, and political reasons, the application of U.S. military specifications, standards and regulations applying to U.S.-developed systems cannot reasonably be applied across the board to a system that has evolved in a military and social environment different from that of the U.S., and therefore having significant differences in approach to end use, maintenance, logistics, and parts selection. The extent to which this does occur can be correlated to the need to accept ever higher costs.

For starters, there is a discernible philosophical difference between U.S. and European aerospace engineers. The Euromissile representative to Boeing, Bruno Didelot put it this way.

> In the U.S. an engineer is inclined toward a greater emphasis on analysis, less on synthesis. This results from both his training and the structure of U.S. aerospace firms. The european engineer is in charge of a wider range, and places more emphasis on the goal, less on the detail of how to get there. Instead of documenting exact dimensions we often will rely upon the workers eye-balling it.

Then, more specifically, there are differences in RDT&E practices between the U.S. and European nations which are often simply the result of differences of scale. The U.S. can usually try more approaches to solving a problem before deciding which one to use. While for Europe, the scale of the effort often does not allow for the luxury of trying out numerous possible developmental options. Instead, after deciding which option(s) have the highest probability of success, their developmental efforts tend to concentrate on working within that more limited range. This difference results, in practice, in the prototype testing of a developed system in Europe being very intensive.[243]

a. Manufacturing Technology and Standards

Even though European developmental technology is not behind that of the U.S, the technology involved in manufacturing often is. In the area of standards, over the last few decades Europe has been closing the gap with the U.S., but the manufacturing technology required to reach those standards has continued to be different. Though this is now changing somewhat, in Europe the lower production runs and the more highly skilled, less mobile, artisan-type work force has generally led in the past to a less capital-intensive approach to manufacturing than in the U.S.[244] This often results in a greater tendency to build up parts rather than fabricate them out of single work pieces, while using a higher increment of labor.[245]

With U.S. manufacturing tending to be more heavily capitalized and with a work force operating in accordance with detailed instructions, it would be inefficient to set up a retrograde manufacturing capability in the U.S., based on previously abandoned practices. There is consequently the need to indulge in some degree of product redevelopment so that the system conforms with current U.S. manufacturing technology.

Likewise when technical data and/or know-how are transferred in the opposite direction, from the U.S. to Europe, an adjustment is necessary one way or the other. The Europeans can adapt the foreign drawings, standards, tooling and test equipment to their own internal practices, or they can change their way of doing things to conform with that of the U.S. licensor or prime contractor. Usually this will involve a mix of both, depending on circumstances, e.g., the

size of the recipient firm, its capitalization, the sophistication of the work and the scale of production. Either way the adaptation costs time and money. Of course, this problem is further amplified by the difficulty of aligning the independently-arrived-at military specifications, standards, and regulations with a foreign-developed system after the fact, and any tendency of the procuring service to specify additional modifications to the system.[246]

One example of far greater dependency having been placed on the "know-how" of specialists, surfaced when it was discovered that a larger percentage than expected of the E/M-procured hardware was not per drawing. For proper fit of these parts, it appears that there was an unwritten but specific agreement between engineering and manufacturing to do what is required to make the parts usable. Another example of this greater reliance on craftsmanship involved two Turkish women in one of the European plants, who had the task of adjusting spin rates on gyros—something which they accomplished by listening to the pitch of the sound.[247] In the end the U.S. adopted its own design for the gyro, not Euromissile's.

The reputed American proclivity for tinkering, once again, is not the principal reason that foreign weapon systems produced in the U.S. under license undergo some degree of "Americanization." Europe, with its generally smaller production bases, and in the case of France and the FRG, a break of 5 to 11 years in the national defense efforts, has had further to go with modern weapon systems. And European approaches to production systems vary depending upon the customs, traditions, labor practices, tool design, and capital structures of the national industries concerned.

Consequently, weapons designed and manufactured according to the production standards of any European country entail some conversion to U.S. production standards of reliability, safety, serviceability, and so forth.[248]

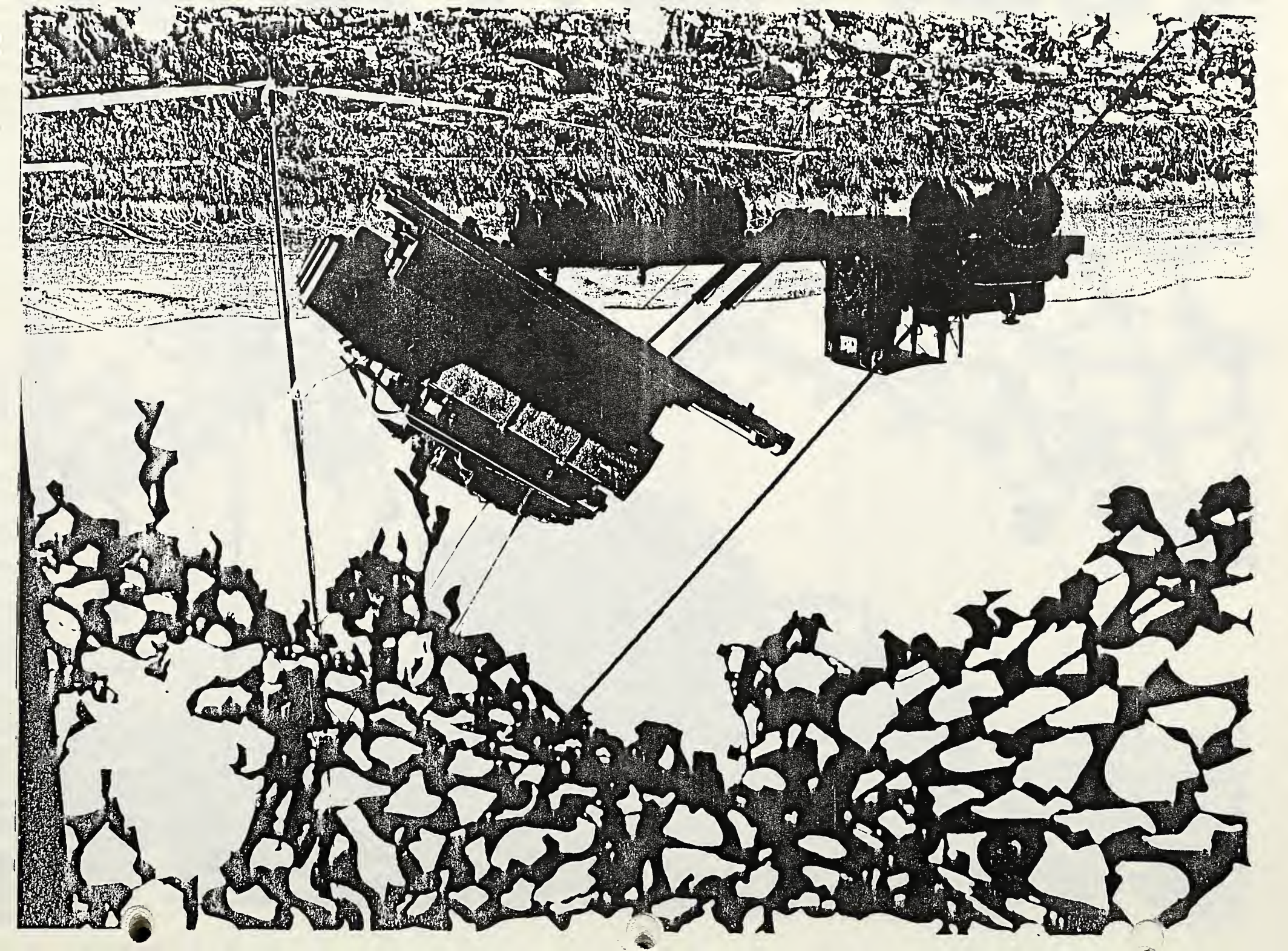
The RATAC project (see previous subchapter) amply brought this out for both production standards and military requirements. This involved such areas as the more stringent safety standards for electronic components and variations in mill-rolled metal gauges and alloys, as well as the more severe environmental requirements called for by the worldwide deployment of U.S. Armed Forces.

Amplifying on his prior point concerning philosophical differences in engineering, Euromissile's Bruno Didelot described how this flowed through to manufacturing and quality assurance.

> Take the example of burs on the oriface of the safe and arm device in the missile. On the Euromissile side, the approach was one of relying on the experienced eye-ball of the worker, ascertaining under a microscope that the oriface was smooth and clean. the U.S. on the other hand wanted exact physical criteria so that any one could make and guage whether the surface was adequate. For critical precision work we are comfortable with relying on the workers. Most of those currently on the missile production line at Bourges today in 1982 have been there since it started up in 1976. Our manufacturing work force has considerable responsibility for quality assurance. We have a much thinner Q.A. staff.

Yet another example brought out by BAC's U.S. Roland project experience involved packaging, which is generally not designed with producibility or maintainability in mind to the extent it is in the U.S.:

- Back plane wiring utilizes motherboards and daughterboards which require an unusually high number of hand solder operations;



- Inaccessibility of modules for replacement and for troubleshooting (Inverter, BITE, Cabin Power J-Box);
- Less attention to thermal transfer mechanisms; and
- Several P.C. boards are used to complete a single circuit, which results in far more interconnect wires.[249]

In addition, the E/M artwork on P.C. boards was not up to either Military or Contractor Standards in the area of line weight, line spacing, pad size, registration and grid spacing.

Other examples of different approaches emanating from Value Engineering Change Proposals (VECP's)-for time and cost savings generated on the U.S. side and cited by Didelot, include several examples of different solutions involving the missile:

- lock supports—Euromissile used three stamped pieces bolted together whereas the U.S. contractor used one part and chose a slightly different stainless steel.
- end caps (for the launch tubes)—Euromissile used foil with a welded circumfrance, which encountered some aging problems, so the U.S. chose a one piece aluminum cap that was thicker and more rigid.
- the blast tube—the Euromissile design called for the use of fiberglass and silicium phenalic but these resulted in what the U.S. judged to be exessive scrap. The U.S. therefore looked for another solution and chose to use cotton phenalic.

Didelot was also able to discern a difference between the two U.S. licensees with regard to substitution of U.S. components and processes, and VECP generation generally. He observed based upon his experience that Hughes was more inclined than Boeing to change over to their own practices or ideas as to how the job should be done.

It must be kept in mind, however, that over the last decade vast strides have been made by Europeans, not only in developing weapons technology but in translating it into quality-tested products that more than meet the operational requirements of the particular national service concerned. In light of the continual advances being made in European manufacturing technology and standards,[250] the exercise of caution will continue to be ever more necessary in the future to ensure against unnecessary "Americanization" of European designed weapon systems produced in the U.S.[251]

b. Testing

In addition to the above manufacturing/Americanization considerations in the process of transition from a European engineering model (built and working) to the U.S. production model, there is another closely inter-related point where the question of how much is enough arises—i.e., additional testing. In this case, in addition to the specifics of conversion to a more capital-intensive U.S. manufacturing technology, there is the broader range of problems that arise with any second-sourcing situation. The conversion of manufacturing processes, materials, techniques, and procedures already covered, impacts testing.

European and U.S. manufacturers produce the same subsystem using identical drawings, but fail to duplicate each other's product exactly. Although after the program was restructured this was no longer as serious an issue, U.S. test methods, techniques and equipment were still often different, and thereby provided results in some cases below the specification requirements. Drawings sometimes exhibited small differences when compared to actual hardware—leaving the question of performance impact unanswered without additional testing. Moreover, since some of the materials and processes used by the Europeans in fabricating the missile are either different in the U.S. or simply not available in the U.S., they had to be altered and tested for their potential impact on system performance.[252]

Given that many of these problems do arise in any second-sourcing situation, there are more differences between Europe and the U.S. Thus, once again, some degree of additional effort in the retesting of components and subsystems is inevitable. The question again is, how much?

One example involved the propellant, the characteristics of which produced in the U.S. by a qualified supplier, Hercules, had slightly different burning characteristics and therefore different performance characteristics than the original propellant manufactured in Europe. This was due to differences in the manufacturing process and made it necessary for BAC to procure technical assistance through Euromissile from the French manufacturer SNPE and commit extra resources to assure that the change did not degrade missile performance. Other examples included: a U.S firm would receive a set of specifications that called for a particular processing method that it had never used before,

or perhaps calibration techniques that were different from those in the U.S., or the U.S. firm's procedures and facilities for testing were slightly different in some way. Thus, after conversion[253] to U.S. processes, materials, techniques and procedures, are the converted components equivalent or is additional testing required, and if so, how much is called for? And each time one of these questions is confronted, how will the response affect the system's performance? The problem is not so much one of transferring the technology on paper, but rather one of integrating the technology into that of the U.S. firm, and, while making some needed changes, still ensuring that system performance is not degraded.[254]

In light of these problems, it is was important that both industry and the customer— in this case the Army—accommodate to the situation. This also required industry to be more flexible in its manufacturing and testing processes. It also required the customer to be somewhat more flexible in modifying his acquisition procedures to incorporate the nuances of a technology transfer and fabrication and test (TTF&T) agreement.

In commenting on the customer's responsibilities in this regard, John H. Richardson of Hughes made the following comment:

> Significant time and cost savings could be realized on certain performance tests and design verification if the U.S. would accept the results of equivalent tests conducted in Europe. Ideally, only limited performance testing and environmental verification tests should be conducted in the U.S. to amplify on foreign testing and to verify that the technology was sufficiently transferred so that U.S. manufactured hardware performs as well as the European-made hardware.[255]

When the resolution of the problems of adaptation (i.e., standards, manufacturing technology, and technical and performance specifications for the different military services) are pressed down to the contractor level, these problems are likely to be magnified. The best solution is prior planning and the establishment of a centralized controlling authority in advance of the specific project to resolve most important differences before assigning the work to industry.

In the words of John Richardson, "Because of the extensive testing requirements laid down by DoD, the current technology transfer process falls somewhere between a true second source, and regular research, development, test and evaluation program."[256]

One can easily imagine the rather unique and delicate role that the Army Project Manager had to fulfill. It was fortunate that such an individual as Brigadier General Frank Rogano was assigned the job. But aside from the good support the U.S. contractors got from General Ragano and the Army, probably the biggest aid in solving problems like these lies in the simple fact of having worked together in developing acceptable procedures.

For the U.S. firm and military agencies considering a joint program, understanding of this overall situation and of the learning period required in the adaptation of European technology will help considerably.[257]

6. Procurement

a. The Division of Work

The transfer of the Roland II technical data package (TDP) to the U.S. and its conversion by Hughes and Boeing to U.S. drawing and documentation standards, were only steps along the way toward the goal of setting up a second source on this side of the Atlantic. The TDP next had to be digested by the industrial engineering teams at Hughes and Boeing prior to decisions being made on the extent to which the system would be "Americanized": (1) impacting the performance of the ultimate U.S. variant of the Roland II, to both take advantage of the technological advances and options available in the U.S., plus to meet the peculiar operational, and logistics support requirements of the U.S. Army; (2) while also permitting the manufacture on the most economical basis by U.S. industry, i.e., the question of producibility of the TTF&T prototypes, and later the production series units. This presented no easy set of trade-offs.

One sub-set of (2) above were the make-buy decisions of the U.S. industrial team.

The manufacturing of the U.S. Roland can be broken down into 6 main categories:

(1) the assembly and test of the U.S. Roland system by the co-licensees for delivery to the U.S. Army;

(2) manufacture by the co-licensees of European designed subsystems;

(3) U.S. subcontractor make of European designed subsystems;

(4) U.S. contractor (co-licensees or subcontractors) design and manufacture of U.S. unique subsystems;

(5) European procured subsystems unique to the Roland system via the licensor, Euromissile) and;

(6) European procured detail components, that were commercial standards, directly from their original manufacturers or distributors.

The distribution of responsibilities between Hughes and Boeing are covered in the charts on the next two pages.

b. The Subcontractor Team

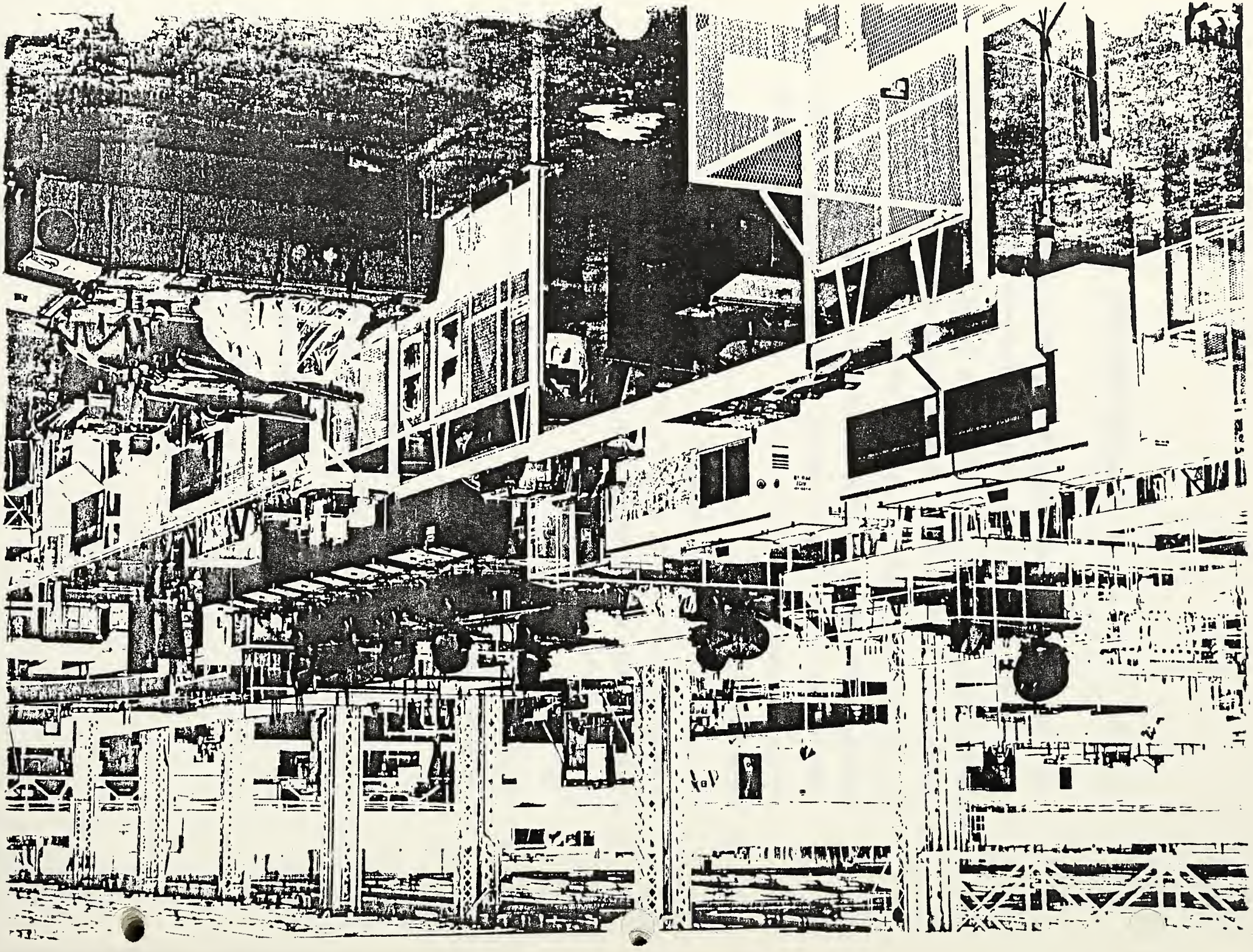
The license gives Hughes and Boeing full freedom to subcontract in the conventional manner. Normal bid and procurement procedures are employed, with the usual legal restraints that the data may not be used for any other purpose. However, as is not uncommon in license production arrangements, certain subcontractors of the licensor, Euromissile, would not release data for manufacturing purposes because of patent considerations. These problems were resolved, but in some cases it required that Hughes and Boeing write their own performance specification for the subsystem for issue to U.S. industry for bidding.[258]

Another wrinkle of the U.S. subcontractor effort was that none of these firms could buy system unique components from Euromissile itself but they had to be prime contractor procured, i.e., CFE.

Within the division of work between the co-licensees described on the preceding pages, the respective subcontract teams were as follows:

BOEING'S PRINCIPAL SUBCONTRACTORS (LRP) FOR THE FIRE UNIT AND PECULIAR SUPPORT EQUIPMENT (PSE)

American Electronics	Prime Power Unit
Barry Controls	Shock Isolators
Chen Industries	Battery Charger



Euromissile (Fr/Germ)	Hydraulic Assemblies
	Trainers
	Test Equipment
Fluids Control Division	Air Conditioner
G & H Technology	Umbilical Plug
	Umbilical Receptacle
Hewlett Packard	FMTS Equipment
ROTEK	Pivot & Turret Bearings
Teledyne Cast Products	Floor Casting
	Launch Arm Casting
	Commanders Console Casting
Kevlin Manufacturing	Rotary Joint
Flex Circuits, Inc.	Flex Circuit
Lebanon Steel Foundry	Cupola Castings
Souriau (Fr/Germ)	Connectors
Garbe Lahmeyer (Germ)	Valves
ECE (Fr)	Electrical Components
Deutsch (Fr)	Connectors
MORS (Fr)	Slip Ring Components
SAMM (Fr)	Hydraulic Components

BOEING MISSILE PRINCIPAL SUBCONTRACTORS (LRP #3)

Hercules, Inc./ABL	Sustainer Grain
Talley Industries	Booster Grain
Holex, Inc.	Booster Igniter
MB Associates	Sustainer Igniter
Thiokol/Wasatch Div.	IR Flare
Holex, Inc.	Squib, IR Flare
Special Devices, Inc.	Neutralization Charge
Special Devices, Inc.	Safe & Arm Components
Teledyne Kinetics	Safe & Arm Switch
Goex, Inc.	Warhead Loading
Rex Precision Products	Lock Support Casting
V&W Casting	Wing/Wing Base Casting
Kaiser	Booster/Sustainer Motor Case-Forgings

C. U.S. Designed Subsystems

Though most of the U.S. production effort was second source for European designed components and subsystems, with minor changes to account for U.S. producibility or manufacturing processes, by no means was all of it. There were three major subsystems involving independent U.S. design efforts:

- the environmental control unit (ECU), and;
- the primary power unit (PPU).
- the track radar

The first two cases of independent U.S. development efforts, the ECU and the PPU, both resulted from the initial decision to go with a modular fire unit for the U.S. Army, one that could either be inserted in the designated tracked vehicle or operate independently as a self-contained unit i.e., transported by helicopter or by truck. In France and the FRG, the respective Roland II fire units were integrated into each nation's chosen tracked vehicle on their respective assembly lines. With the decision to go for a modular design for the U.S. Roland, the U.S. fire unit had to be able to operate independently of the tracked vehicle. This break out of the guts of the system from the vehicle required that these two totally new systems be developed, the ECU and PPU. 259

For the ECU, a small outfit from Cincinnati was selected for the TTF&T program, Ellis and Watts. Development was problematic. An acceptable system was ultimately produced, but only after the spec had been changed. For low-rate production (LRP) E&W was competed against the Fluids Control Division of LFE. The latter firm won the contract.

The development of a PPU with a diesel powered generator proved to be even more problematic. First, there was a lack of interest on the part of suppliers contacted due to the difficulty of the task. There was a severe credibility problem with regard to the goal of getting the amount of power required out of the small module. Fermont Diesel of Bridgeport, Connecticut was selected for the TTF&T phase. Numerous design, fabrication, and test problems ensued which required a great deal of technical support from Boeing. With the TTF&T program completed, three firms competed for LRP 1 & 2 production (21 fire units): American Electronics was the firm chosen. For LRP, after another competition, American Electronics continued as the supplier.

Boeing initiated significant improvements in both the ECU & PPU and both later performed very well, with no serious problems cropping up during low rate production.[260]

Hughes decided that they could substantially improve upon the Thompson-CSF track radar, and with U.S. Army concurrence, set about designing and testing a new one of their own design with higher power as a first step toward an increased ECCM capability. Though the Hughes designed radar was ultimately produced and delivered, the not unusual unforeseen schedule delays involved in such efforts led to a substantial delay in the delivery of the majority of the 27 U.S. production series fire units.

d. Boeing's European Procurement

Second source production in the U.S. by the co-licensees and their U.S. suppliers eventually entailed substantial purchasing from Europe, especially with regards to the work package allotted to Boeing.[261] In light of this, further reinforced by the favorable Boeing-Euromissile procurement relationship, Boeing was eventually appointed to handle all European procurement for the balance of the TTF&T program. This purchasing involved both technical assistance and hardware, and for the latter could be broken down into Roland unique subsystems and components which had to be bought through the licensor Euromissile(which in turn procured them from SNIAS or MBB), and commercial standards.

All purchases were in francs or marks depending on the nationality of the ultimate supplier. For TTF&T and LRP 1 and 2, the U.S. Government insured the contractors against any gain or loss by the adjustment of the rate used for progress payments (an arbitrarily pegged program rate, 1 DM = $.50 and 1 FF = $.21) every six months to cover the difference between it and the market rates actually paid by the contractors (this arrangement also applied to license fee which was paid in Deustchmarks).

For Boeing this foreign procurment activity came to around $300,000 for technical assistance from Euromissile provided both in Europe and on site in the U.S. by SNIAS, MBB and other European subcontractors (e.g. SAMM and SNPE). The reason it was this low was that most of the technical assistance was provided in scope to the manufacturing license agreement. There was also around

$20 million for hardware purchases from Euromissile; i.e., for Roland unique subsystems.

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Euromissile Procurements (Planned)

SNIAS	Organizational Maintenance Test Set (OMTS) - System Test Set (STS)
MBB	Trainers
	Miscellaneous detail parts (e.g., selector switches)

SAMM (procured through SNIAS/Euromissile - planned)

Nomenclature	Installation & Function
Actuator	Cupola—Actuates Command Antenna
Motor Pump Assembly	Platform—Powers Turret Servo
Servo Motor Assembly	Platform—Drives & Controls Turret
Gear Box, Turret Drive	Platform—Drives Turret
Elec. Motor Pump Assy	Cabin—Powers Magazine
Magazine Servo Block	Magazine—Controls Magazine Rotation

Gabe Lahmeyer (through MBB/Euromissile - planned)

Check Valve	Magazine—Magazine Door Control
Brake	Launch Arm—Launch Arm Control

AEG-Telefunken (through MBB/Euromissile)

Command Transmitter Antenna

Command Transmitter Radome

Numerous detail elements of the Command Computer

Souriau GmbH (through MBB/Euromissile)

Electrical Connectors and Contacts

In addition, there was around $2½ - 3 million of procurement for the high volume of detail parts that were commercially available in Europe (the type of hardware ordinarily handled by a Central Purchasing Department, but transferred to program Materiel for the U.S. Roland). This procurement was handled directly with lower-tier European suppliers.

The purchasing from the licensor, Euromissile, was done within the framework of two negotiated Basic Purchase Agreements (Master Purchase Orders or Basic Ordering Agreements (BOA's), one for each category of procurement. The detail commercial parts were bought under a six-page English language Boeing T&C's document entitled,

The Boeing Company

General Provisions

Fixed Price Purchase Contract-Foreign Supplier

Roland Program

DF 4400-527

These General Provisions covered the usual array of clauses:

- Packing, Shipping and Delivery
- Inspection
- Warranties (one year)
- Governing Law (State of Washington)
- Arbitration (Revised Code of the State of Washington).
- Changes

- Termination/Cancellation
- Applicable DAR Clauses
- Quality Assurance System Requirements (AQAP-1) and Government Source Inspection
- Audit by French or German Governmental Agencies

Yet another aspect of Boeing's European purchasing was the procurement through Euromissile of several million dollars worth of "production bail-out" hardware from German and French industry. This included for the most part, the covering of shortages cropping up during the early phases of low-rate production (LRP) and centered primarily on hydraulics and castings (both machined and unmachined) and elements associated with the missile command subsystem in the fire unit. These were usually small quantity procurements of one to several units, but in a number of cases also stemmed from a belated throwing in of the towel on the U.S. production source, opting instead for a European buy for the balance of the U.S. production program.

For "production bail-out" Boeing was extremely dependent upon Euromissile's ability to obtain MBB and SNIAS agreement on juggling assets within the tight schedules of their own larger production efforts to cover U.S. Roland program shortages. (In one case Boeing was able to reciprocate, though the development of such mutually beneficial support was cut short by the U.S. Army's reduced buy.) This consideration also applied to a lesser extent to all other procurement from Euromissile, and served to justify this otherwise cumbersome and expensive multi-tier procurement heirarchy.

Per the license agreement the co-licensees were required to handle all procurement of Roland unique hardware from Europe not only for themseleves but for their U.S. subcontractors (a fairly standard though negotiable clause in license agreements). As mentioned previously, this procurement had to be furnished through Euromissile and provided by Boeing to its U.S. suppliers as contractor furnished equipment (CFE). One major example of this involved the special break-away connectors used on the umbilical wiring assembly connecting the missile and fire unit. The U.S. source for the assembly was G&H, while the connectors were bought by Boeing through Euromissile and MBB from the firm Souriau GmbH, a subsidiary of the French firm Souriau located in Dusseldorf, FRG.

In the assessment of BAC's Len J. Savage and Gene Mikov (Roland Materiel's Cost Manager from 1977-82), Boeing's principal European procurement problems can be enumerated as follows:

- No cost data was submitted by Euromissile. Factors only were provided over the table during major negotiations for the consolidated procurement of planned hydraulics, OMTS/STS and the trainer. For the balance of the hardware purchased on a piece meal basis, the buyer had to rely on certification and what little procurement history was available.
- Audits by the French government (per the umbrella MOU's) requested through MICOM for the multi-million dollar consolidated procurement were made available to the U.S. government, but only long after the fact (a year and a half later). No adjustment of contract price ever resulted from these audits.

- For that portion of the procurement that had to be through Euromissile the multi-tier approach generally cost in both money and time.
- Covering shortages and the procurement of detail parts out of Europe involved heavy management involvement, both through: (1) for shortages SNIAS and MBB were periodically requested through Euromissile to juggle their assets, and (2) for both shortages and detail parts procurement BAC's Roland Program Paris and Munich representatives had to be constantly brought into the act.
- Obtaining the right for Boeing QA and Engineering reps to participate in the acceptance testing of the OMTS/STS at SNIAS.

For purchase contracts with French or German firms, the following DAR clauses were deleted (though never sanctioned at the prime contract level until 1980!)

DAR Reference	Title
7-104.15	• Examination of Records by Comptroller General
7-104.41(a)	• Audit by Department of Defense
7-104.42(a)	• Subcontractor Cost or Pricing Data
7-104.29(a)	• Price Reduction for Defective Cost or Pricing Data
7-104.83(a)	• Cost Accounting Standards (CAS)
7-103.83(b)	• Administration of Cost Accounting Standards
7-104.37	• Required Source for Jewel Bearings
7-104.38	• Required Sources for Miniature and

	Instrument Base Bearings
7-104.46	• Required Sources for Precision Components for Mechanical Time Devices
7-104.93(a)	• Preference for Domestic Specialty Metals

Notwithstanding the above, in the area of Cost Accounting Standards (CAS), the BOA with Euromissile actually required compliance with CAS 401 and 402 only, although CAS in its entirety was waived for contracts with all the other French and German firms.

Payment schedules for the annual multi-million dollar consolidated procurement of PSE and hydraulics from Euromissile reflected the common European practice of advanced and milestone payments (e.g. 30% within a month of contract signature, 30% a year later, and 40% upon delivery).

Certificates of Conformity (Certificat de Conformite or Uebereinstimmungsbescheinigung) stamped and signed off by the approved French or German government QA representative were required with all hardware delivered to Boeing.

The major QA issue arose over the right for Boeing to review SNIAS work-in-process and participate in accpetance testing for the OMTS system test set. After the first test sets came in for TTF&T showing signs of shoddy workmanship plus configuration variance between each set, Boeing QA insisted upon levying the right of Boeing to inspect the LRP units at SNIAS prior to

delivery. SNIAS strongly resisted, being afraid that Boeing might try to shut down the whole STS production line which predominantly included units for the French and German armies. They insisted that this was a French government responsibility. Boeing QA's position was that the U.S. government levied the responsibility upon Boeing. Resistance was finally overcome when the approval of the SNIAS program manager was obtained.

The AQAP-1 levied upon European suppliers was equivalent within France's defense industry QA system to the RAQ-1, (RAQ - Reglementation pour l'Assurance de Qualite, AQAP-4 equals RAQ-2 and AQAP-9 equals RAQ-3).

Another example of the extra effort involved in foreign procurement is provided by a QA report in May 1982. Over the previous six-month period, 85% of the 2770 parts received from Euromissile had been rejected. However, only 13 of the 2770 items received ever required return to vendor for repair, the balance being dispositioned use as is. The extremely high rejection rate, though time consuming for Receiving Inspection and Materiel, was not because of hardware deficiencies but represented primarily: simple paperwork corrections; inability to decipher 'foreign gibberish' on forms; and configuration clarification such as the level to which assemblies were broken down for shipment, alternate P/Ns, and P/N revisions.

A number of minor problems associated with European procurement that impacted engineering (i.e., the Peculiar Support Equipment Group) were also noted. One of these involved parts substitution practices which resulted in use of piece parts that were not reflected on the European drawings' parts list. Another

issue raised was that reliability data was often nonexistent and after the fact for European purchased equipment.

The receiving inspection problem referred to above, is symptomatic of other problems. For one, there is a need for close tracking of international shipments in an environment where Murphy's Law tends to prevail. There also tends to be a wide variance with regards to adherence to schedule. Both of these mean that greater time and costs for the communications involved are unavoidable.

Assuming shipments came in properly marked and addressed, processing through customs was rapid. All shipping documents consigned the shipments to the U.S. Army in care of Buyer, and claimed Duty Free-Entry, citing the relevant prime contract. The District Director of Customs at the designated Port of Entry (Seattle) releases the shipments and notifies the appropriate DCASR. The listing of all eligible prime contracts must be kept up to date by the buyer working through the local ACO. When improperly addressed shipments came in to the U.S. through other than the designated Port of Entry (e.g., for expedited shipments) the contractor faced the dilemma of having to pay the duty or wait weeks for the hardware and paperwork to be realigned.

Since hardware sent back to Europe for repair, entailed export of Munitions List items, in compliance with the U.S. Governnment's International Traffic in Arms Regulations (ITAR), a Temporary Export License (DSP-73) had to be obtained annually[262] from the U.S. State Department's Office of Munitions Control (OMC). Euromissile had to obtain an equivalent export license on their

end from the French Ministry of Defense's DMA-DAI. The lapsing of this latter agreement at one time held up deliveries to BAC in early 1982 for a one month period.

Though standard prime contract language calls for the utilization of U.S. flag carriers for all shipments, this could not be strictly adhered to due to the lack of direct airline connections with Seattle from either of the program's two European points of origin, Paris and Munich.

The French government too had its documentation requirements. Boeing had to correlate all hardware receivals with those on 'Soumission' reports received from the French Customs Authorities via Euromissile, and pass on copies of all receivals and reports to the ACO to get her verification that defense hardware which Euromissile claimed it had exported to Boeing Seattle had actually ended up there.

One additional point of a more positive nature, the U.S. Roland program was able to benefit from the support of another BAC program with a substantial presence in Europe, the NATO AWACS Project. This was especially true after the second restructuring in the fall of 1981, in particular for Materiel support in the Munich area and Q.A. support for acceptance testing in France.

e. The Interim U.S. Roland Agreement for French Government Audit of European Subcontractors

In September 1976, at the time the restructured program was being launched, an agreement was reached for dealing with the issue of subcontract audit in Europe. It was entitled (in the English version of the original copy) "Interim Arrangement Between the U.S. Department of Defense (DOD) and The Ministry of Defense of the Republic of France Governing Audit, Evaluation of Price Proposals, and Post-Award Audits of Contracts and Subcontracts by U.S. & French Audit Agencies."

The interim arrangement was for the U.S. Roland specifically and signed by the U.S. Army Missile Command's (MICOM) Deputy Director of Procurement Production, and by the Delegation Ministeriale a l'Armament's (DMA) Directeur des Affaires Internationales (DAI), and concurred to by the Comptroller General of the U.S. As Euromissile was a French legal entity, the French government assumed this responsibility for both European nations though delegating the audit of German firms to its counterpart in the FRG, the BWB.

This agreement was required because, under the original concept of the program, manufacture of equipment was to be entirely within the United States pursuant to commercial licensing agreements. However, once a more realistic approach to second source production had been adopted, and due to program exigencies that arose after the U.S. Government had awarded the initial contract, it became necessary for certain articles manufactured in France and the

FRG to be purchased from Euromissile (located near Paris) by U.S. contractors.

In the interim agreement each government recognized the principle of reciprocal exchange of audit information between governments as being necessary and desirable.

In Article 3 of the interim arrangement, price certification for Roland system components were covered. MICOM agreed that certification (stating that prices of European subcontractors to the Roland prime contractor were not greater than those quoted to and accepted by the French Goverment taking into account differences between U.S. and Franco-German orders for the same items of Roland equipment) provided by the French government could satisfy all requirements for price survey of the said contracting agencies. (The Paris based Bureau du Programme Franco-Allemand provided this certification of proposal prices until the spring of 1981, at which time it refused to continue the practice referring the U.S. authorities to relevant French and German audit agencies that ordinarily handled such requests. After that point, certification provided by Euromissile was all Boeing received.)

Prior to audits the competent services of the two countries were to meet to develop the goals as well as the scope and depth of the survey so that these corresponded well to the needs of the authority that requested it. This meeting could involve contractor's agents and include a visit to the contractor's office or plants. It was agreed that the service in charge of the audit would make sure that the other party was told of any difficulties encountered during

the audits and would call for a new meeting, if need be, to make the necessary adjustments.

After making the audit and before writing the corresponding report, the service in charge of the audit would meet with the requesting service, and proceed if need be, to obtain any necessary supplementary information to complete the survey.

In exceptional circumstances where the appropriate French audit agencies declared officially that they could not or would not perform such audit or price survey within reasonable time limits, the audit or price survey requested was to be performed, at the option of the contracting officer, by the DoD or the GAO, whichever was concerned.

The French audit agency concerned was to be apprised of the results of the audit, and provided access to the DCAA or GAO documentation

Any difficulties arising out of this special provision were to be resolved by the manager of the DCAA European branch office, or the Director of the GAO European Branch, both located in the Federal Republic of Germany and the head of the appropriate French audit agency. The difficulties or disputes that were not settled at that level were to be brought up to higher authorities of the two countries.

In the absence of a price certificate from the French Government, the governments agreed that requests for an on-site audit or price survey could be made

by the contracting officer or his representative (DCAA). The appropriate French audit service would perform the necessary evaluation and/or audit and provide a complete audit report including an opinion as the the correctness of the financial and costing records and statements at the conclusion of the audit. They also agreed to provide an analysis reflecting United States standards and cost principles.

In the agreement the U.S. Comptroller General consented to the exercise of his audit rights in France through the appropriate French audit service.

The American requests for surveys in France were to be addressed by the DCAA or the DOD purchasing services to the President of the Comite de Coordination des Services d'Enquetes de Prix (CCSEP)-Coordination Committee of Price Investigation Services. For the Comptroller General they were to be addressed to the Government Commission located with the contracting or subcontracting company.

Boeing requested two such audits during the life of the program, one to support TTF&T procurement and the second time for LRP 1 and 2. The first one was forwarded to the U.S. Army about 18 monhts after requested, stating the results were satisfactory. A similar audit was completed for LRP 1 and 2 in a comparable time frame but the results were never forwarded to the U.S. Army. Lead-time constraints naturally nixed any posibility of these audits providing support to negotiations. There was no DCAS to DCAS 30 day turnaround time.

Furthermore, not unexpectedly, Euromissile made it clear from the beginning that there would never be any prenegotiation Boeing fact finding at SNIAS or MBB. The audits consequently requested by Boeing were a point of irritation to Euromissile, SNIAS and MBB, especially because (as is indicated by the long lead time) the French government did not perform proposal audits per se, but company-wide audits of rates and factors. These full blown audits were too time consuming to help negotiations, there being no short fuze mechanism for proposal review.

f. 1980 Multi-program Agreement on Reciprocal Audit Support by the U.S. and French Governments

The 1976 U.S. Roland specific interim agreement was superceded in 1980 by an annex to an umbrella MOU signed at the ministerial level to cover audit in both countries for any and all joint programs. To the MOU dated 22 May 1978 between the Government of the United States of America and the Government of the French Republic, relating to the principles governing their reciprocal purchases of weapons equipment, Annex II was added in 1980.

Annex II was entitled "Concerning Price Investigations". Similar to the early agreement, each of the signatory governments agreed to conduct on behalf of the other in its own country, price proposal evaluation investigations and post-contractual investigations concerning purchases of weapon systems.

Per Article 2, the investigations would be conducted in conformance with the provisions of this agreement by the following authorities:

For the Government of the United States of America; the Defense Contract Audit Agency (DCAA).

For the French Government, by a price investigation service of the Minister of Defense designated by the President of the "Coordinating Committee of Price Investigation Services" (CCSEP) for investigations requested by the Secretary of Defense of the United States, and by the Government Commissioner located in the company with which the contract or subcontract has been concluded for investigations requested by the General Accounting Office (GAO).

Each party would receive from the other all information, including disclosed accounting practices, in support of the negotiation activity or contracting service, normally communicated to its own contracting agencies.

Each government agreed to accept the investigation services conducted for it by the other government as if it had conducted them itself.

Per Article 3, the investigation request shall be sent to the following authorities.

- Upon request by the French government agencies - the cognizant contracting procurement service, as concerns purchases subject to the procedures of U.S. Foreign Military Sales (FMS), and to the director of the Defense Contract Audit Agency, Cameron Station, Alexandria, Virgina, for all other purchases.

- For investigations requested by the DOD - the president of the Coordinating Committee of Price Investigation Services, General Delegation for Weapons, 14 rue St-Dominique, 75997 Paris.

- Upon request by the GAO - the manager of the Military Equipment Construction Monitoring Group, 14 rue St-Dominique, 75997 Paris.

These requests are to be accompanied by all necessary documents (offers, estimates, contracts, annexes, etc.).

Per Article 4, the price investigations for contracts in a country shall be based on the accounting principles and practices in effect in that country.

Before the start of each investigation by one government agency on behalf of the other, per Article 5, the representatives of each country were to meet or consult in order to determine the objectives and extent of the investigations. These preparatory meetings may include the presence of representatives of the contractor and may include inspections at the headquarters and plants of the contractor.

Investigations performed according to the terms of this agreement were to cover all costs and identify the total amount of the profit. The contracting parties were to take maximum advantage of the available information obtained beforehand by the service in charge of the investigation.

The investigation reports had to answer the questions contained in the investigation requests. The report was to enable the requester to evaluate, completely independently, the acceptable nature of the price proposals or of the costs according to the respective national regulations.

Upon request by the contracting service, additional information supplemental data and explanations or clarifications were to be provided to it or to its duly authorized representatives.

Article 6 dealt with the eventuality wherein, if, due to extraordinary circumstances, one of the governments declares that it is not capable of performing the investigation within a reasonable period of time, then the services of the contracting country would be entitled to complete the unconducted part of the investigation themselves.

In the event of persistent disagreement, the matter would be brought before the superior authorities of the two countries.

Article 7 covered the divulging of the basic data and the investigation reports to third parties, communication of the final result of the investigations from a subcontractor to the contractor of higher rank for purposes of the negotiation; protection against unauthorized disclosures; and nondisclosure of professional information that would weaken the competitive positions of the contractors and subcontractors.

7. The Congressional Debate, 1978-1981

a. FY 1979

After dying down in 1976 with the restructuring of the U.S. Roland TTF&T program, criticism within Congress began to once again gather strength in early 1978 with the beginning of FY79 discussions over plans for initial production. The House Armed Services Committee (HASC) authorized the requested $210 million, but only with the proviso that the Secretary of Defense certify to Congress that the U.S. Roland had been adequately evaluated and would meet its specifications. The committee was concerned that total costs were now double the original estimates and that the Army had revised the initial low rate production procurement from 15 fire units and 314 missiles to 7 fire units and 157 missiles to remain within requested funds.[263]

The Senate Armed Services Committee (SASC) took even stronger action by reducing $103.3M from the program and directed that the remaining funds be used to continue the production planning and tooling effort. Further, the committee directed that the performance deficiencies revealed by the test program had to be corrected before production could begin. During the conference to resolve the HASC/SASC differences, both committees agreed to authorize $165M to initiate low rate production for 3 fire units and 75 missiles. This amount was also approved by the House and Senate Appropriation committees.

A special OSD review of the TTF&T phase had in the meantime been held in June of 1978, and determined that the U.S. Roland was suitable for engineering

Services and Initial Production Facilities contracts, which were awarded shortly thereafter, to a value of $56.3 million. DSARC III approval to commence Production, however, was postponed from October 1978 to May 1979.[264]

b. FY 1980

The FY79 criticisms were mild compared to those raised in FY80. First the military acquisition review process, the ASARC and DSARC, having slid from the prior year, now took place in the middle of the congressional budgetary cycle. As a result, the Committees did not have all the data, and internal disagreements within the Army surfaced during the hearings.

Secondly, Secretary of Defense Brown delayed the low-rate production decision until after the normal conclusion of the authorizations. Finally, the General Accounting Office (GAO) published a report critical of the U.S. Roland, the substance of which was used by the relevant committees as the basis for their questions.[265]

The HASC concluded that Roland was not cost effective and deleted funds for both procurement, and research and development. The committee noted that acquisition costs had increased over four times the estimate given in 1976. Further, using the results of cost evaluation studies by TRADOC, the committee believed that a mix of alternative systems could perform the U.S. Roland's mission at less cost. Some weight was also given to the GAO findings.

The SASC was not much more positive. The committee was concerned about the reported performance deficiencies of the U.S. Roland, its cost effectiveness and was interested in the Improved-HAWK and Chaparral as alternatives. The Army studies and the GAO report were again used as the basis for questions. To pursue the matter further, the SASC convened a special session to allow Undersecretary for Research and Engineering, Dr. Perry, and Assistant Secretary of the Army, Dr. Pierre, to respond to congressional criticism. Both testified strongly on Roland's behalf and as Dr. Perry stated of the alternatives to Roland, "Those available are not equal and those equal are not available." (FY80 SASC 3, p. 1388).

Perry and Pierre's testimony together with a successful challenge to the GAO and cost evaluation studies, plus the value of Roland to NATO RSI (in particular, it being tied to the planned adoption of the Patriot medium and high altitude SAM system by our European allies — chief among them France and the FRG) convinced the SASC not only to approve full funding but also to persuade their House counterparts to do likewise. Both the Appropriation committees approved the funding as required but only after extensive questions, and again with particular emphasis on the decision of the Army's system acquisition review.[266]

c. FY 1981

In FY81, although Roland was still singled out for special notice, congressional interest was less intense. The questions raised by the four committees were similar. In particular, there was considerable unhappiness about the

fluctuating support of the Army. All four committees found it difficult to accept, especially after the statements made in FY80, that the Army for reasons of fiscal constraint had reduced the Roland buy from four to two battalions and apparently was no longer considering Roland for the divisional role. Because of the Army's position, Congress became interested in a Roland/I-Chaparral combined deployment. There were also questions asked about the use of the British system, Rapier, to protect U.S. air bases in the UK. Despite congressional concern, the requested funds for production were approved, but $10.6M for spares were reduced without prejudice.

Despite its critical attitude, Congress had come to support the Roland. In September 1980, when the HASC learned of a 60% proposed cut in air defense by the Carter administration, the committee reacted angrily and sent a strongly worded letter to the Secretary of Defense—a reaction which clearly had an impact because the funds were later restored. In reaction to the inconsistency of the DoD's and the Army's support for the U.S. Roland and air defense priorities generally, Congress requested that the DoD submit an air defense plan.

In a letter to Harold Brown concerning the request for the air defense plan, Congressman Dan Daniel stated, "The committee's major objective in requesting such a plan was to abandon the practice of examining each year's budget submission and to move toward endorsement of a long range program that could be reviewed annually within a multi-year context....We know you recognize that the failure to fund Roland in fiscal year 1982 would severely damage the credibility of DOD." (October 28, 1980).[267]

d. FY 1982

Production to be authorized in FY82 for deliveries in late CY83 and CY84 was proposed for 25-30 fire units and 600-800 missiles; the exact number to be determined during summer and early fall 1981.

The original request for $529M was initially reduced sharply because of total budget limitations placed upon the Defense Department, and in turn on the Army, by the Carter administration. This forced the U.S. Army into prioritization problems which eventually resulted in a sharp decrease in the funds available for the U.S. Roland. The final submittal to the Congress by the Carter administration was for only $65M for the U.S. Roland.[268]

After extensive study by the in-coming Reagan administration, in early 1981 an additional $464M was requested in a supplement, thus restoring the total amount to $529M. The Armed Services and Appropriations Committees of both House and Senate received the posture statements and recommendations of the administration. The Senate Armed Services Committee approved the full request while the HASC recommended a $117M reduction. The issue was resolved in the Joint Conference Committee in early July and the Senate position prevailed, i.e., the full $529M was authorized.[269]

Furthermore, the Army was recommending (once again) recognition of the four-battalion requirement in the 1983 POM. They had also requested FY83 funding of $642M.

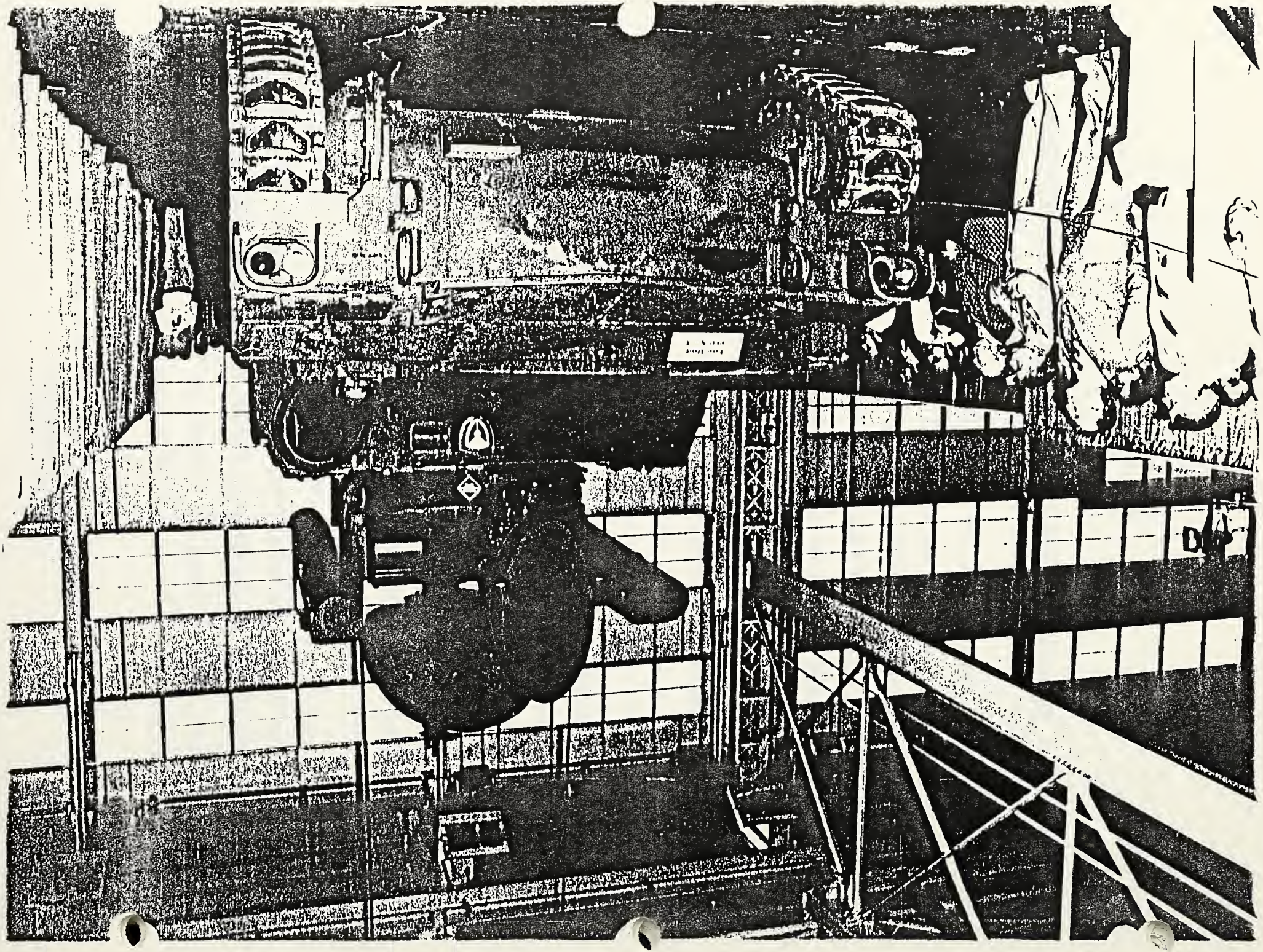
8. The Sequel

a. The Second Restructuring of the Program (1981): Soft Termination

Through the summer of 1981, the U.S. Roland program appeared to be finally on solid footing, making its way into its third U.S. Administration. The Army supported a 180 Roland fire unit program and 6000 missiles, and expected Congressional approval of a budget in excess of $450 million for Roland for FY82. Prospects for foreign sales were also good. Norway was expected to sign an LOA that fall, and Canada, Jordan and Korea were thought to be not far behind. Furthermore, Boeing was active in the area of off-set in furtherance of the Norwegian sale, presenting bid opportunities on fire unit structural subassemblies to Norwegian industry.

Then in September, the Reagan Administration found itself faced with a larger budget deficit than anticipated, and ordered each armed service to quickly offer up for sacrifice one program on the altar of budget reductions. In spite of the $1.3 Billion already invested the Army chose its adopted off-spring, the U.S. Roland. This time though, unlike under the two prior Administrations, the DoD would not step forward to save the project.

The original intent was to terminate the program entirely, but with 38 fire units and 895 missiles already under contract and the delivery of the first production fire unit one month away (aided by a successful demonstration at the AUSA), the Army backed off. Instead the Army chose to negotiate with Hughes and Boeing for a restructured program of 27 fire units and 595 missiles



for use with the Rapid Deployment Force (RDF), terminating the balance. This restructured program would only come to $50-60 million for FY82 and FY83 and bring the low rate production program to completion (while covering termination costs which included elimination of the protection against nuclear, biological and chemical (NBC) warfare).

In addition, due to the new RDF rule and the inability to fit more than one fire unit plus M109 tracked vehicle into a C-5 cargo plane, the Army decided to refurbish 30 dumpster type tracks for a cost of about 6 million dollars. The Roland fire unit module could thus be rapidly slipped on and off of the flat bed of the truck for surface transport.

b. Optional U.S. Army Uses

At this point, the contractors proceeded with a low cost effort to try and emphasize the systems potential: augmentation with the small Stinger (SAM), transportability by truck, the CH-47 and the C-141; and its use as a command and control center in conjunction with either shoulder-fired Stingers or the Chaparral clear-weather short-range SAM systems that the U.S. Roland were originally intended to replace.

As for the Stinger in particular, it is a small surface to air missile (SAM) system developed by General Dynamics for shoulder firing by a foot soldier against aircraft flying at low attitudes. It weighs about 10 kilograms and has a range of 3 miles. The missile, with infra-red guidance, is autonomous after firing.

In the spring of 1982, the U.S. Army and Boeing successfully carried out the firing of Stingers from a U.S. Roland fire unit, a system designed for the launch of radar guided SAM's. This demonstration, which constituted a first, took place within the framework of the annual maneuvers of the U.S. Army's 9th Infantry Division at the Yakima Firing Range in the State of Washington. On April 29, a Stinger missile fired from a U.S. Roland by a Boeing team, passed within 20 centimeters of the target (clearly within the warhead's lethal range.) On May 1, a U.S. Army team successfully reperformed the operation.[270]

The aim of the operation was to demonstrate the possibility of utilizing the infra-red guided Stinger with a U.S. Roland fire unit originally conceived for missiles with ecartometric radar alignment. The idea was to expand the flexibility of use and fire power of the U.S. Roland weapon system. The weapon system, designed to ordinarily carry and fire 10 U.S. Roland missiles could carry up to 40 Stinger missiles. Boeing developed a missile pod allowing for installation of 4 Stingers in place of one Roland in the same Roland Standardized launch tube-transport container. But the most probable mix for the weapon system would be 5 Roland and 20 Stinger; the two missiles being fired alternately by the fire unit, as the threat evolved.[271]

Euromissile, which observed the Yakima firings, also decided to study such an enhancement of the ROLAND weapon system for the firing of a short-range infra-red SAM. It was being designed specifically for defense against anti-tank helicopters which constitute the principal threat to tanks, the system to which the Roland is assigned for protection against air attack.

In a separate effort, Euromissile was going forward with an improved version of the Roland missile which would increase range by about 1/3 over that of the current one. This would give the improved ROLAND a range of around 8 kilometers. This new missile will also have greater speed than that of the current one (1.6 mach).[272]

Despite interest in the possibilities offered by the dual Roland/Stinger option in some quarters of the Army the program could not be rescusitated. The other options explored were also based on the goal of enhancing systems already in the U.S. Army's inventory and involved the Chaparral, and again the Stinger. The idea was to have the Roland serve as a central command and radar unit providing direction to a number of heat seeking Chaparral and shoulder fired Stinger systems deployed around it.

c. The Rapier Resurfaces

Meanwhile, in mid-1979 the British Government had decided to take another run at selling the Rapier SAM system to the U.S. Armed Forces. Having been closed out by the Roland II in the 1974 U.S. Army competition, the British thought they might have located another opening with the U.S. Air Force.

In talks in Washington D.C. in October 1979—Senior British government officials were pushing sales of the British Rapier to the U.S. Air Force for use in defending the seven U.S. air bases in Britain. This would serve as the first step in a complex program to increase the capability and effectiveness of Air Defense of the U.K. The team was led by Geoffrey Pattie, under

secretary of state for the Royal Air Force in the recently formed government of Prime Minister Thatcher.[273]

The British plan was to push initially for greater U.S. purchases of military equipment built in Europe which could be maintained and used there by U.S. forces.

Pattie cited the usual argument to Aviation Week & Space Technology, i.e., that the imbalance in military purchases at that time was about four to one in favor of the U.S., and purchase by the U.S. of the Rapier, for which there is an immediate need in defending U.S. air bases in Europe, would be seen by the British and other Europeans as an initial step in redressing this imbalance.[274]

The Thatcher Government was elected on a platform of bolstering British defenses, especially air defense. Initial steps to increase British air defenses were seen as no more than a short-term, stop gap effort. These included bringing about 20 English Electric Lightning supersonic fighters out of mothballs to form one additional squadron, equipping a number of the RAF's BAe Hawk subsonic trainers with the capability of carrying Sidewinder AIM-9 infrared guided missiles. Longer-term solutions centered on the planned deployment starting in 1985 of the air defense version of the MRCA, the Tornado F-2, and the possible acquisition of additional McDonnell Douglas F-4 Phantoms (as the St. Louis production line had closed these would have to be second-hand), and of course the acquisiton by the U.S. of the Rapier for defense of its own air bases in the U.K.

The following excerpts from a testimony before the U.S. House Armed Services Committee hearing on the procurement of the BAe Rapier SAM system was reported in the Defense & Foreign Affairs Daily of February 21, 1980.

Rep. Dan Daniel, Chairman of the House Armed Services Subcommittee on NATO:

> When the NATO Subcommittee was in session last year, the inadequacy of our air defense especially in the UK was highlighted. These bases are unprotected and it is suggested, and rightly so, that the UK Rapier system is the cheapest and most cost-effective solution.
>
> "It is reported to me that the British have offered to man the system, but that the Carter Administration has described this as a form of employing mercenaries. But this is really a non-issue. We are not talking about some potentate sending people 3,000 miles. We are talking about the UK military protecting their own turf and at a cost of only $3.5-million per year.[275] I understand that USAF favors the program but that it has not been funded because of affordability and roles and missions. My view is that the roles and missions argument is irrelevant. Why should we not procure Rapier just as fast as we possibly can?

Dr. Hans Mark, Secretary of the US Air Force:

> I agree with much that you have said. The problem is now to negotiate with the British the circumstances under which the deal could go ahead. The O&M and personnel costs are rather high and are considerably more than the figure of $3.5-million which you quoted. Never before have we been asked to pay the cost of foreign personnel manning US-acquired systems. We are agreed in principle. We will buy the missiles and they will man it. The question is who pays the manning?

Rep Daniel:

> Is it a fact that we have no quarrel with the principle of the British manning the system?

Gen Lew Allen, Chief of Staff, US Air Force:

You are right. The question is who should bear the cost of manning. The British now provide area air defense, but these air bases are now vulnerable to the long-range aircraft now coming into the Russian inventory. Point defense is needed and I acknowledge that point defense is now a matter of growing concern. Roland is too expensive for the job. Rapier is the best way to go. It is only a matter now of horse-trading on who should pay the cost of manning.

Rep Daniel:

Rapier meets our requirements; it is cost-effective; the only question must be which force should operate it. Why should the USAF not acquire the system now and then settle the personnel issue?

Dr. Mark:

Rapier is more labor-intensive than Roland and this was one reason why Roland won out in the original Shorads competition. But the UK has offered to man the system and I believe we are very close to the end of the negotiations. Therefore, to separate acquisition from the manning arrangement should not be necessary. I think the program will be achieved.

Rep Daniel:

I hope so. Of late, I have been most impressed with the attitude and co-operation of the UK government on mutual defense matters.

In May, 1980 a formula covering procurement and deployment of the Rapier's was finalized by Secretary of Defense Brown and his British counterpart, Francis Pym.

The U.S. Air Force agreed to purchase 32 fire units of the Rapier under terms of a memorandum of understanding signed by the two governments on February 13 of the following year.

The order would be worth approximately $315 million to British Aerospace, which was to sign a formal contract with the British government immediately thereafter.

The systems were to be operated by the Royal Air Force Regiment under terms of an agreement whereby Britain would pay the cost of manning the air defense missiles in return for the U.S.'s waiving much of its usual assessment to recover development costs of the Lockheed Trident II submarine-launched ballistic missile, which was being purchased for the Royal Navy.[276]

The U.K.'s total contribution for the Trident II development thereby was reduced to only $116 million.[277]

In March 1982, the British Aerospace Dynamics Group and United Technologies announced that they had signed an agreement under which United's Norden Systems would manufacture British Rapier missiles in the U.S. Norden, had been teamed with McDonnell Douglas back in 1974 as co-licensee of the Rapier.

Norden President Herman A. Michelson stated that

> Compatibility of British and American standards used in the manufacture of Rapier have been proven. Norden Systems has produced, unchanged, Rapier modules which were used in the British system. This complete interchangeability required no 'Americanization.'[278]

The USAF was faced with a similar air defense problem for its bases in the FRG. The possibility of an agreement along the lines of that reached with the U.K. came under consideration for these forward bases. The two primary

solutions discussed were another Rapier buy to be operated by the British in the FRG, or a Roland buy off the Euromissile/MBB production line utilizing German troops for their operation. As we'll see shortly, the latter solution became tied in with the USA/Raytheon Patriot SAM system procurement planned by the FRG as possible off-setting purchases.

d. The Debate Continues

The termination of the U.S. Roland production program was to add a sour note to relations with the two allies concerned. Two examples of the repercusions of this decision over the following months are cited below

An article in the October 16, 1981 issue of Le Monde entitiled "The Paris Visit of the American Secretary of Defense" was subtitled "M. Hernu expressed to Mr. Weinberger his 'extreme concern' over the cancellation of the Roland missile order". The article emphasized that even though the two defense ministers were of like minds on the more general defense issues under discussion, the differences raised by the American termination of the purchase of the Franco-German Roland were far from resolved. Hernu did not conceal his irritation and expressed his opinion as to the 'aggravating precedence' this act would create, impacting the 'two-way street' in the transfer of military technology and equipment between Europe and the U.S. The French Minister even went as far as to link the U.S. decision to the U.S. Navy's trainer competition involving the Franco-German Alpha-jet for which Lockheed would likewise serve as the U.S. licensee for production of a USN variant.[279]

Some 15 months later echos were still being heard. Here we cite an example from the other side of Rhine. The January 17, 1983 issue of Aviation Week & Space Technology ran an article entitled, "U.S. Protecitonism Irks Germans." The article went into the cries of outrage, betrayal, and threats of countermeasures coming out of the German Ministry of Defense, and Bundestag in response to the re-instating of the specialty metals clause in the new U.S. Defense appropriations bill.[280]

German industry officials were saying the specialty metals clause effectively closes the U.S. market to foreign arms manufacturers because nearly all arms components include some specialty metals.

German political leaders, for their part, were threatening a ban on arms purchases from the U.S. in retaliation for what they call a "pure protectionist provision."[281]

A similar provision had been included in the last Defense bill, but the effect was moderated by exemptions. In addition, foreign officials had delayed retaliatory action because the Reagan Admininistration had pledged its efforts to avoid a renewal of the provisions in the legislation approved by the House of Representatives and cleared through the Joint Conference Committee.

Pointing out that the specialty metals clause decision came in the wake of series of U.S. government decisions "that have angered the European allies,"

the article cited, " Among the more important was the U.S. government's decision to cancel purchase of the Euromissile Roland surface-to-air missile after five years of efforts to sell the missile to the U.S."[282]

In the meantime the debate continued through the winter and spring of 1982 in the U.S. over how to fill a remaining gap in the nation's air defense posture. Giving up its U.S. Roland purchases for FY 1982 and beyond allowed the Army to save some $2.8 billion, including $2.25 billion in procurement costs.

However, diversion of previous Roland air defense missile system purchases from European to Rapid Deployment Force units didn't affect the U.S. Army in its NATO theater requirement for an all-weather, low-altitude system. According to a senior Pentagon official cited in January 28, 1982 issue of Aerospace Daily, the Defense Department had no idea how or when the requirements would be satisfied.[283]

With U.S. Roland out of the NATO picture, the Division Air Defense (DIVAD) gun would be the only U.S. system available for all-weather defense against low-flying aircraft. Improved Hawk and, later, Patriot would provide this capability against higher-altitude threats. Officials believed though, that few if any DIVAD units will be pulled back to the rear areas Roland was intended to serve.[284]

"Cost and affordability have been cited as the main reasons for terminating Roland", the Pentagon offical quoted in Aerospace Daily said. "Hindsight shows that the U.S. shouldn't have Americanized the already-developed French-German system. No one dreamed it would cost so much."

The loss of Roland is "a military problem graded somewhere between moderate to serious," Gen. Edward C. Meyer, Army chief of staff, said in closed congressional testimony given Oct. 7 1981, and published in early 1982 by the House Appropriations defense subcommittee.

But, the January 28, 1982 issue of Aerospace Daily continued, the Army "has consistently believed that this (Roland) is its lowest priority in ground air defense modernization." Improved Hawk, DIVAD, Partiot and upgrades of two clear-weather systems, Chaparral and Stinger, "should provide an acceptable degree of adverse weather protection," the Pentagon said. Prior to the soft termination and the decision to deploy the U.S. Roland with RDF units, Meyer had however listed Improved Hawk, Chaparral and Vulcan as inferior alternatives for the specific requirement.[285]

That spring the debate over a low-altitude all weather air defense system for deployment in Central Europe began to take a new direction. The focus shifted away from the Army Corps/in-depth defense need, towards a secondary requirement for defense of the Air Force's bases.

In April 27, 1982 issue of Aerospace Daily it was reported that "the House Armed Services Committee thinks the service should buy air defense systems for its German and Dutch bases the same way it is getting Rapiers for bases in the U.K."

The House Armed Services Committee voted an unrequested $50 million for an arrangement with the U.K. or Germany to defend forward Europena bases patterned after the current Rapier agreement for U.K. bases.

The Air Force should "explore all off-the-shelf alternatives" for short range defense of the continental bases and buy whatever system offers "the best combination of cost-effectiveness and early availability," the committee said.[286]

It is "incongruous" to defend U.K. bases better than the continental ones simply because Roland was canceled, the committtee commented, and it is "unacceptable that the United States should be spending billions of dollars for fighter and attack aircraft for possible use in a war in Europe and yet virtually nothing to ensure their survivability on the ground European air bases."[287]

The committee noted "a degree of sensitivity" about the Air Force defending air bases, normally an Army mission, but it said such defenses represent "a critical deficiency...that traditional divisions of responsibility have exacerbated. Air base defense, by its very nature, is inherenlty a higher priority to the Air Force than it is to the Army."[288]

As for one of the higher priority U.S. Army air defense systems, the DIVAD with its radar controlled twin 40 mm cannon, the not unusual problems resulting from comparsion of one's own 'superior' paper design systems to someone else's existing proven system began to appear. The DIVAD was

juxaposed to the Roland on the low end of the air defense spectrum, somewhat overlapping each other. In 1982 the decision had been made to go ahead with the production of the system prior to the completion of test and evaluation of prototype units (and, as came out later following an investigation of DoD's inspector general, on the basis of test results wherein the Army had alledgedly with held damaging test data). Problems continued to plague the performance of the DIVAD (again not unusual in early stages of a systems life cycle), falling short of expectations in its ability to rapidly and accurately locate targets along with the old Roland problem--ECM susceptibility. Then more general criticism arose over the systems specified characteristics such as the speed of the vehicle and the range of the guns.[290]

In October 1984, U.S. News & World Report came out with an article on the system entitled "Anatomy of a Pentagon Horror Story." As a result of the difficulties cited above and the $1.5 billion already spent, the article stated "Only the threat of a revolt by Congress is now forcing Defense Secretary Caspar Weinberger to take a new look to decide whether the project should be canceled." The article concluded with a standard journalistic wrap up,

> The final chapter in the saga of the DIVAD has yet to be written. In the face of refusal by Congress to grant more production funds, Weinberger has decided to conduct a review of the project and carry out further tests next year. If he hopes to save the weapons, it is clear that he will have to convince Congress that the bugs indeed have been eliminated and that the DIVAD actually will work.[291]

Once again the scenario is played out, with the dilemma of a need to make cost, schedule and performance projections for systems of varying maturity and

capabilities while selecting from among them. 'Ours' versus 'theirs', Inter-allied political implications or not, it's a difficult business.

e. The 1984 Roland-Patriot Barter Agreement

The need for point defense of U.S. air bases in Central Europe along with the gaps left by the Luftwaffe's cancellation of its Roland buy for the same role led to negotiations over the next several years between the two governments. These culminated in the signature of an MOU on July 12, 1984. This $2.87 billion agreement involved a very complex sort of barter agreement centered on two SAM systems - German Rolands and American Patriots - wherein industrial jobs, government appropriations, military manpower, maintenance, training and R & D costs were all offset against each other. The FRG agreed to purchase 95 fire units from Euromissile in return for the U.S. commitment to purchase 14 additional Patriot high altitude SAM systems from Raytheon for Luftwaffe use—all for deployment at a mix of US Air Force and Luftwaffe bases in the FRG. The above is in addition to pre-existing U.S. procurement plans for 12 Patriot systems to be deployed by the U.S. Army in Central Europe and the Luftwaffe's purchase of 12 Patriot units for its own requirements.[292]

From the total of 95 Roland systems, 27 fire units (note the number) will be for the defense of two U.S. main operating bases and one forward operating location with the Germans being responsible for manning and support of these units over a 10 year period. 60 units are being procured for the Luftwaffe's point air defense needs at its own main operating bases - six at which are collocated U.S. operating bases; and eight units will be dedicated to

operational and maintenance training. Of the 14 Patriot units being provided to the Luftwaffe in return for the 27 Roland fire unit deployment at U.S. bases, two Patriot systems are dedicated to maintenance and operational training, and the balance of 12 will be located in the southern part of the FRG at four U.S.A.F. bases in accordance with current NATO plans.

The U.S. agreed to provide transition training to German personnel manning the 12 U.S. Patriot units equal to the value of the training provided U.S. personnel manning the same number of units in the FRG. In addition, the U.S. also will be responsible for depot maintenance for the 12 U.S. Patriot units manned by the Germans and for modifications of these units.

The U.S. agreed to accept the obligations assumed by Germany as offsetting $220 million in research and development recoupment. The U.S. will waive the remaining research and development recoupment charges of $50 million to the extent that the German government provides offsetting funding for the U.S. programs to be mutually agreed upon.[293]

The U.S. programs under consideration include a hardened shelter program for German and U.S. tactical aircraft, development of an extended-range Vought multiple launch rocket system (MLRS) and joint development of the Joint Tactical Missile System (JTACMS) as a counter air weapon.

The two governments also agreed that they would encourage the participation of German industry in providing logistics support for the Patriot units deployed

by both countries in the FRG to facilitate German compensation for expenditures in the U.S. for the systems.[294]

For further German manning of the 12 U.S. Patriot and 27 Roland units at U.S. expense, for the period following the 10 years of German manning agreed to in the July at a later date. Terms will be negotiated by the two government.

It is agreed that the cost borne by the U.S. at that future time will in no case exceed the actual cost to the FRG for the same manning and operational support.

Several weeks after the signature of this monumental MOU it was announced that the two governments were conducting preliminary discussions over the deployment of 30 additional Roland systems to be built by Euromissile and deployed in the FRG during the early 1990's.[295]

f. The Fate of New Mexico Army National Guard Rolands

Now shifting back to the Rapid Deployment Force (RDF) (if your neck is not already too sore from all this jerking around) and its batallion of 27 fire units. In 1983 Army officials were testifing that the Roland was "a necessity" and "essential" for the RDF (Kenneth P. Bergquist, deputy Army assistant secretary). The Roland, Maj. Gen. Herbert R. Temple Fr. said, "is for a specific mission for a specific organization related to the Rapid Deployment Force with that specific mission."[296]

Cost however continued to be an issue. According to a memo Deputy Defense Secretary William Howard Taft IV sent the Army in the spring of 1984, it was too expensive. Each Roland missile, costs $150,000 compared with $88,000 for the improved Chaparral. In addition, the Defense Department calculated that maintaining the Roland as a one-of-a-kind system in New Mexico cost four times more than maintaining Chaparrals. Although the Roland's range and bad-weather capabilities are better, the Pentagon concluded, the difference was not worth the cost.[297] During the summer of 1984 the Roland-RDF unit appeared in a $1 billion package of units to meet deficit reduction demands. Congress and the Army discussed plans to transfer the RDF Roland units to Norway, replacing the RDF units with MIM-72A Chaparral systems.

In early September, on the same day that an Army spokesman at the Pentagon announced that the decision was final—that the DoD would dispose of the RDF Roland units, a Congressional staffer announced that New Mexico Senator Pete Domenici (Chairman of the Senate Budge Committee) was negotiating with the Secretary of Defense to keep the fire units with the New Mexico National Guard. The state National Guard was reportedly furious over the decision.

In addition to taking up the matter with Weinberger, Senator Domenici contacted John Tower, chairman of the Senate Armed Services Committee. He asked Tower to include language in the 1985 defense authorization bill in favor of the Roland fire units being retained by the National Guard unit at McGregor Range (Fort Bliss) New Mexico. Several days later, the press secretary to the other New Mexico Senator, Jeff Bingaman, a member of the Armed Services Committee himself, was able to report that his committee had added the

requested language in its mark-up of the defense spending bill. The actual wording supporting continued deployment in the National Guard was worked out by the staffs of Tower & Bingaman and the bill was reported out of the Armed Services Committee immediately thereafter. The authorization request for the U.S. Roland contained $4.2 million for the Army National Guard and $42.2 million for the Army budget.

Even after adoption by the full Senate, and then by Congress as a whole the Roland's long-term future remained uncertain. The authorization report stated that eventually other options should be considered because of the cost involved with the Roland system. The committee suggested that Roland not be phased out until most National Guard air defense batallions have been modernized, (currently, being equipped with Korean-War vintage equipment). Phase-out was scheduled for 1988-89.

Naturally not just pure military capability had been at stake, several hundred New Mexico jobs as well. These included both the fulltime Guardsmen billets that had already been created at the McGregor Range along with possible future jobs associated with a Central Repair Facility for the missiles under consideration by Hughes and Boeing. Currently only low-level maintenance could be performed locally (Fort Bliss). The balance of maintenance tasks required shipment to prime contractor facilities in California and Washington State.

But the issue just never seems to die. As the politics of the fate of the Roland quieted down domestically they flare up again internationally late in

the year. Towards the end of November 1984 Turkish Defense Minister Zeki Yavuzturk asked his German counterpart, Manfred Woerner, to intercede personally with Defense Secretary Weinberger to transfer the 27 Roland fire units to Turkey. Given the attitude of the U.S. Army and DOD, the Turkish defense minister pressed Woerner at a Nuclear Planning Group meeting to convince Weinberger that the Rolands would serve a better purpose bolstering Turkish air defenses. The FRG which along with the U.S. funds about 95% of the total security assistance program for Turkey, said it was willing to partly pay for converting the U.S. Rolands to meet Turkey's needs. Woerner was expected to push for the Rolands for Turkey at the NATO Defense Planning Council meeting in Brussels the first week of December.[298]

And so the sad tale continues for these weapons without an Army—wandering exiles in the desert of U.S. defense procurement.

g. The Roland as an Alternative to the U.S. Army's DIVAD

As the Divad program continued to experience technical difficulties, Secretary of Defense Caspar Weinberger initiated a monthly review of the program to determine whether it was meeting its testing and performance milestones. Weinberger was to conduct the first review on February 15.[299]

A series of evaluation tests of the Divad system were underway with preliminary results scheduled for the April-May timeframe. Final test results were expected in September.

Meanwhile Army officials continued to defend the Divad system and maintained that results from a limited test in July-August, 1984, were very good, especially considering the limited resources and time available. The system engaged 80-90% of the maneuvering targets in a benign environment and 60-70% in an electronic countermeasure (ECM) environment.

Engagement performance against hovering helicopters was worse however, with scores in the 60-70% range in a benign environment and 40-50% in an ECM environment. The lower percentages for hovering helicopters were due to site geometry problems at one site, and the Army was conducting an investigation into the causes of low performance at the location[300].

Uncertainty as to the fate of the Divad led to a resurfacing of several alternate solutions. One of these was the Roland. In January 1985 the U.S. Army asked the German MOD to provide five Euromissile Roland surface-to-air missile systems to evaluate as a possible candidate for replacing the Divad.

Army Under Secretary James R. Ambrose also ordered that tests be conducted with (1) a Ford Aerospace Chaparral surface-to-air missile system equipped with a forward-looking infrared unit and (2) studies undertaken of the Martin Marietta/Oerlikon-Buehrle adverse-weather air defense and antitank system (ADATs) as additional potential candidates to meet the Army's division defense requirements [301].

The concept of looking at alternatives to the Divad program was proposed by David S.C. Chu, head of the Defense Department's Office of Program Analysis

and Evaluation. Chu was known to be a proponent of a missile system over a gun to meet air defense needs.

The U.S. request for German Roland II's was being evaluated by the MOD. Defense Ministry officials were attempting to determine why the Army would want to test a European Roland system when it had 27 National Guard Roland units with the battalion at the McGregor Range in New Mexico. German officials pointed out that the European Roland is not made for division air defense and primarily serves as an area air defense system.

As for the Martin ADATs system, the U.S. is only studying it as an alternative to the Divad system. Weinberger however proposed a cooperative development program to Canadian officials during the December 1984 meeting of the NATO Defense Planning Council in Brussels.[302]

9. Conclusion

The U.S. Roland program was not just another program. Neither, in its uniqueness, is it likely that it was simply a one-shot token gesture that misfired vis-a-vis the need for an equitable, yet practical approach to strengthening NATO defenses. With this program the DoD, the U.S. Army, and the two U.S. contractors, along with their French and German counterparts, embarked on an ill defined course for which policies and precedents were few. It is generally accepted that if there is to be a North Atlantic "two-way street" it will have to involve a reliance on technology transfer, not just hardware procurement. This is all part of the endless series of ad hoc arrangements by which a compromise is reached between the illusive goal of a thoroughly rationalized North Atlantic defense community a la Warsaw Pact and the 'sauve-qui-peut' tendencies of the all too sovereign NATO member states. Therefore, inspite of the fate of the specific system this program's significance lies precisely in its having participated in the development of many of the new mechanisms necessary for the international industrial collaboration within the North Atlantic Alliance on a broader and more politically acceptable basis.

Of course, the balance between hardware and technology in U.S. purchases from Europe, as well as the extent to which the U.S. will go in order to broaden this inevitably much narrower lane of the "two-way street,"still remains to be seen. Both of these issues will continue to be hotly debated, and, given the scale of the U.S. defense effort, the exercise from the U.S. viewpoint will tend to be more one of damage control than really ever satisfying the demands of any one European nation. The turbulent history of this project, and the

early termination of the U.S. production line, reinforces the view that selling foreign systems in the U.S. defense market, and especially keeping them sold, remains an uphill battle. In the meantime, what was touted under the Ford and Carter administrations as one of the primary examples of the "two-way street" and the U.S. willingness to give greater consideration to foreign solutions to its military requirements is now, under the Reagan administration, repeatedly waved in our faces as yet another example of our bad faith, both on this issue and generally.

As a result of the program's unprecedented nature, it was both highly visible, involved much disruption, and many more ramifications than anticipated. After passing through a period during 1975 and 1976 in which the program and its problems were the center of a great deal of attention (i.e., criticism), the problems were overcome and the program emerged restructured and intact. In spite of the cost growth and delays, the magnitude of the problems would still have been relatively modest in comparison to the overall savings in time and money obtainable through acquisition of such a system on as large scale as planned to fulfill the Army's SHORADS requirement (one that remains unfilled).

In addition to any potential savings realized with regard to the SHORADS requirement, a great deal of experience has been gained by the participants. Both Hughes and Boeing have gained valuable experience in the production of a foreign-developed weapon system. In an interview with Aviation Week and Space Technology in the fall of 1977, U.S. Roland project manager Brig. Gen. Frank

P. Rogano was quoted as saying, through the Roland program, Hughes and Boeing have "gone way up on the learning curve in the arduous task of technology transfer and have put themselves in the forefront in this area."[303]

As stated for other project histories covered in this paper, the specific lessons learned from this program are too numerous to go into in any depth and can only be summed up here. It is better that one reads the whole sub-chapter than fall victim to a quick and facile summation. But here we go anyway:

1. Though an intergovernmental MOU is by no means required in all cases, when foreign systems are under consideration by the U.S.G., with license production in the U.S. being one of the options (as opposed to off-the-shelf purchase), there is a need for the U.S. Government to take a more active role early in supporting the industry-to-industry license negotiations.

2. When this mode of industrial collaboration is under consideration, RFP funding and response time should be adequate to prevent insufficient data being transferred, with the resultant risks with regards to estimation of the system's maturity and performance, and ultimately cost.

3. Major government policy shifts such as the one that surfaced early in the program with regard to NATO Standardization (i.e., international interchangeability (I^2)) are always a danger. Though true for all business activity, it is especially true for interallied projects (especially on the U.S. side).

4. Beware of underestimating the task with regard to transfer and conversion of the technical data package (TDP) (e.g., the volume, unexpected gaps in the data, design differences and drawing convention standards, translation, plus selection/conversion of parts, materials and processes).

5. Once the original TDP has been converted, this is by no means the end of it. In addition to regular updating, major design changes emanating from the licensor (as occurred here with the Thomson-CSF track radar) may "suddenly" appear, especially if the system is only in the early stages of production. Then there are those customer directed changes such as: the modular fire unit; those emanating from safety and environmental standards; plus the new command computer, the new track radar and NBC warfare protection. To be sure, these changes are often warranted, as well as being encouraged by the licensee/prime contractor(s). And then there is the interrelated issue of differences between the European and U.S. industrial bases: these in turn have a bearing on manufacturing technology, standards (e.g., producibility, maintainability, or safety) and their impact on testing in the technology transfer process, i.e., at what point does a TTF&T program start to become a DDT&E one.

6. Inter-related with the design fluidity/modification costs covered above is the fact that the U.S. second source production line geared up too rapidly, attempting to attain virtually 100% U.S. manufactured content almost immediately. Though backing off somewhat once it was realized that this was impossible (or at least without cost penalties increasing on an exponential basis) the U.S. manufacturing effort still went too far

too fast. One of the basic rules of license production is that the repatriation of manufacturing content takes place sequentially on a gradual basis as the TDP is digested (including any 'necessary' changes) and the scale of production warrants. The U.S. government/industry team broke this rule, adding substantially to the up front costs of the program.

7. To make matters worse, the U.S. contractors over capitalized in tooling for the U.S. production line, and the license royalty payments were structured with high rates in the early stages of production only to taper off later as production increased.

8. The year and a half break between completion of the TTF&T program and the startup of Low Rate Production (caused by the Army's juggling of funding priorities) also cost dearly in labor turn-over, the majority of the TTF&T manufacturing personnel familiar with the system, having been transferred off the program in the interim, never to return.

9. The foreign procurement arrangements Boeing set up for this program, though generally representative of those found elsewhere, also bring out some of the peculiarities of operating as a licensee, especially of a foreign system. One among these, the program's unexpected dependency on sole sources from other countries, also contributed to the establishment of one of the U.S. Government's first inter-allied audit support arrangements, this one being with France. This agreement served as a model for

the later umbrella defense procurement MOU between the U.S. and France, and most of the balance of its NATO allies.

10. Continuing on this more positive note, in addition to the audit arrangements mentioned above, other useful mechanisms have been developed, chief among them being the Joint Roland Control Committee composed of representatives of three allied armies, and the whole system to which it served as a capstone.

11. In the future, the DoD should facilitate technology transfer programs by providing for a timely revision of certain regulations and procedures. As emphasized by Roland Project Manager Gen. F. P. Ragano, "The required exceptions to and deviations from the provisions of ASPR must be sought without delay when it becomes apparent that a foreign-developed system is a viable candidate for a proposed U.S. weapon system acquisition. The consequences of awaiting appropriate approvals range from a great deal of ill will to a serious slip in schedule".

12. As pointed out by Col. Malone in a comparison with the WWI technology transfer experience associated with American production of the French 75 mm gun, the issues of metric data/standards conversion and foreign language proficiency had reversed themselves as to relative difficulty in the intervening 60 years; metric and standard conversion no longer being problematic, but the foreign language skills of Americans having since substantially deteriorated.

13. The difficulties of marketing a foreign weapon system to the U.S. government and all its components (the DoD, armed services, and Congress) does not end with the initial competition. Keeping it sold can be an even more arduous task.

As discussed in Chapter 10 with regards to another Boeing system with significant foreign design content, the NATO PHM program, such projects are highly vulnerable to destabilization, especially as Administrations change. As with the NATO PHM, administrations have a tendency to view the commitments of its predecessors as so much excess political baggage that can be thrown overboard. The initial support that surfaces within the Pentagon and the given service for a system of foreign parentage is hard to sustain over the long run.

The scale of the U.S. services resources and requirements not only dwarfs that of our allies but, allows the U.S. services to operate in relative autonomy, nurturing along all of their own systems from conception on into production. When small and short lived windows of opportunity appear for foreign systems, they are usually for what is perceived as marginal military requirements. Otherwise, the service(s) would have been already developing a system tailored to its own measurements.

Furthermore, with the usual independence of the U.S. services, inter-service coordination and standardization is hard to come by, as occurred here with the U.S. Air Force coming in five and a half years after the

Army had selected the Roland II over the Rapier, with a buy for 32 Rapier fire units.

The British Harrier is the only major success story since the 1960's. The Harrier was able to persevere in spite of opposition from the Carter administration and Navy, because of the unwaivering support provided by the U.S. Marine Corps and the Senate.

14. The case of the Harrier AV-8B offers food for thought. Though it, too, barely survived, the limited off-the-shelf buy, followed by further development in the U.S. prior to production in the U.S. on a large scale, might offer a more sustainable approach.

The August 1977 edition of the General Research Corporation's NATO Standardization and Licensing provided the following commentary on the future of the program:

> In general, the Roland Project Office believes that the Roland program provides a reasonable and workable model of technology transfer to realize the objective of NATO standardization in weapon systems. The evolution of the weapon system from its present TTF&T phase to full field operability is under the control of the three industrial participants, Euromissile, Hughes, and Boeing. Under these circumstances, interchangeability may be difficult to maintain without tight configuration control. The situation is compounded by the fact that any improvements made by the U.S. participants cannot be conveyed to the Europeans without State Department export license approval. This initial program nevertheless is helping to establish a framework in which any subsequent weapon system of any kind can be transferred and further developed. Approaches to operations, logistics, maintenance and repair, etc., can all be adapted for future systems which will have as the ultimate objective an improved NATO fighting capability.
>
> After an initial period of caution and wariness regarding being overpowered by the U.S. industrial behemoth, the Europeans have relaxed

> considerably, and relations between the parties continue to improve. The Joint Roland Control Committee, of which there are six subcommittees, and the obvious U.S. commitment to commonality and interchangeability have given the needed reassurance to the Europeans.[304]

The Malone monograph provides an additional conclusion from his comparison of the French 75mm piece and Roland experiences, one that provides further historical perspective in referring to the evolution of U.S. experience in technology transfer from an intra-national scope in the face of the production requirements of World War II to the international scope required for NATO and other allied security demands of the Cold War.

> As noted, similar problems of technology transfer were to recur in World War II, during efforts to transfer manufacturing capability from the aircraft to the automotive industry to build B-24 Liberators, for example. Similar problems occurred even in transferring production from plant to plant within the aircraft industry. But with each transfer in the United States, lessons were learned to apply to the next. Today if RSI is to succeed, we must extrapolate the lessons learned NATO-wide from each civil and military industrial experience.[305]

May future projects involving this mode of industrial collaboration, license production in the U.S. of foreign weapon systems, benefit from the perspective provided by the U.S. Roland project experience.

Now, $1.4 billion and nine years later the New Mexico National Guard is contributing an air defense battalion of 27 U.S. Roland fire units and a little under 600 missiles to the Army's Central Command (which has assumed the Army's Rapid Deployment Force function).

[133]P. Langereux, "Firing of STINGER missiles by a Roland Weapon System," Air & Cosmos, May 15, 1982.

[134]The number of crew members required or employed can sometimes be confusing. The U.S. ROLAND crew for a TTF&T fire unit was made up of one commander, one gunner, and one vehicle driver. The system can be operated in both clear-weather and all-weather configuration with only the commander and a gunner. The commander can launch, track and perform all other functions in an all-weather mode without the gunner. If the Army decides to include a third crew member within the module, the total complement will be four.

[135]General Research Corporation (GRC), NATO Standardization and Technology Transfer, Volume II — Main Report, (hereinafter referred to as GRC (1977)), August, 1977 (Final), pp. A-1 to A-2.

[136]Richard G. O'Lone, "Roland Effort Tests Technology Transfer" Aviation Week & Space Technology, Nov. 14, 1977, p. 18.

[137]Ibid.

[138]Both nations have also ordered complete Roland fire units as spares: France—26 Roland I and 12 Roland II fire units; and the FRG—54 Roland II fire units.

[139]GRC (1977), op. cit., p. A-2.

[140]Brig. Gen. Frank P. Ragano, USA, "U.S.Roland - A Giant Step Toward Weapon Commonality" (hereinafter referred to as "Giant Step"), Defense Systems Management Review, Vol. 1, no. 3, p. 9.

[141]This was further reinforced by the Yom Kippur war and the lessons it provided in the area of air defense.

[142]Ibid., p. 9-10.

[143]The Rapier entered the picture again in 1980, but this time as a USAF order for its air bases in the UK. The plan was that the U.S. would buy 28 Rapier SAM launchers, test equipment and missiles, and pay for contractors to carry out servicing and spares support. Norden was to produce elements of the system under license. Under the formula, the UK will man the systems and provide training, for an "equivalent quid pro quo" from the U.S. ("U.S.: Brown Clears Rapier Deal," Defense & Foreign Affairs Daily, May 27, 1980, p.2.)

[144]The two licensees approached their teaming relationships, their joint license responsibilities, and their respective contract roles with the Army as associates from the outset. In fact, associate contracting was recognized as the first choice by the team members with the caveat that if the Army preferred, one of the partners would be prime contractor. When it became obvious that the Army preferred a single prime contractor, the teaming agreement was amended. However, this prime/sub relationship was established for TTF&T only. Low rate production was negotiated and contracted on the basis of an associate contract.

[145]The HOT and Milan are head-to-head competitors in the NATO and world anti-tank missile markets with Hughes' TOW system.

[146]For more on Euromissile and its three jointly developed projects see Chapter 8 (Mode #3 of industrial collaboration).

[147]Hughes was actually the lead firm in the NATO Air Defense Ground Environment (NADGE) consortium Mode #7 of industrial collaboration, treated in Chapter 3.

[148]Around the same time that the Exocet project was launched, the Bundesmarine and MBB started the Kormoran project, but MBB being short on propulsion technology, took on Aerospatiale as its main subcontractor.

[149]In addition to establishing a working relationship with the two European firms and learning how to reach protocol agreements with little difficulty (both of which led to the Roland agreement), Boeing learned a great deal about the technical and manufacturing capabilities of its European partners. One particular lesson learned at Boeing about how the Europeans do business during all this, was the fact that the Europeans did not place the same emphasis on schedules as we in the U.S., treating schedules more as optimistic targets, than firm commitments.

[150]The U.S. Navy issued its RFP for systems definition of the Harpoon anti-ship missile in December 1970. Following Boeing-Electronique Marcel Dassault (Exocet guidance system) talks on collaborative/arrangements initiated in the fall of 1969, the U.S. Navy expressed interest in the Exocet, a comparable system which was some three years ahead of its own Harpoon program. This initial expression of a positive attitude by USN personnel was further reinforced by the aforementioned direction from the Office of the Secretary of Defense, concerned over the drain on R&D funding caused by the heavy operational requirements of the war in South East Asia, to pay strong attention to foreign developed systems in order to shorten availability and conserve U.S. development funds.

When it came to actually crossing the Rubicon, however, the U.S. Navy balked and Exocet marketing efforts ran into several serious snags. For starters, with regards to aligning the two schedules, the U.S. Navy would not accept an Exocet proposal prior to the system's first launch, originally scheduled for April 1971, but not actually occurring until some months later. Meanwhile the Harpoon program went forward with the selection of McDonnell Douglas and, once the Harpoon program was underway, the USN considered it too costly to finance a duplicate program. Another reason expressed by the USN was its unwillingness to rely for such a major requirement on procurement offshore. Though not publically stated, other unofficial reasons for the decision included a USN bias against foreign systems, accompanied by assorted logistics concerns.

[151]Alex Munro, BAC Legal Counsel, conversations with the author, August 1979.

[152]Thomson-CSF was Hughes' French partner in NADGECO. In an attempt to expand upon the excellent working relationship established during the NADGE project, Thomson-CSF invited Hughes to be its partner for the U.S. competition.

[153]John H. Richardson, "Roland, a Technology Transfer Program", Defense Systems Management Review, Vol. 1, no. 3, 1977, p. 13.

[154]Until it was sold in 1978, The Boeing Company owned an 8.9% share of MBB, having been a 33.3% shareholder of Boelkow, along with Aerospatiale which also held a 1/3 share.

[155]Alex Munro, op. cit.

[156]GRC (1977), op. cit., p. A-13.

[157]Alex Munro, op. cit.

[158]Ibid.

[159]The issue of rights included in the license agreement is treated in the following section.

[160]For Norway the missiles will actually be purchased from Euromissile while the fire units will be from Hughes/Boeing.

[161]Boeing News, Vol. 37, No. 25, June 22, 1978, p. 1.

[162]Munro, op. cit.

[163]Ibid

[164]The Europeans began the Roland Program with an analog computer and subsequently decided to employ a digital computer which was to be interchangeable with the analog computer. The U.S. then had three options; use the European digital, develop a U.S. digital, or manufacture the European analog computer. Though the U.S. digital computer was originally chosen because of significant cost savings and its design permitting growth in self-test capability and system performance, due to its larger memory and greater speed in the end the MBB digital computer was selected for license production at Boeing.

[165]The flow of most data to Boeing and all U.S. subcontractors has been via Hughes. However, some data has flowed directly to Boeing, as required to support specific requests or requirements of Boeing.

[166]GRC (1977), op. cit., p. A-4.

[167]John Marriott, "Has America Bought the Wrong Weapon?," NATO's Fifteen Nations, December 1975 - January 1976, p. 79.

[168]Erwin Molnar, Boeing Aerospace Company, International Plans & Operations Memo, dated June 9, 1977.

[169]Malone, op. cit., p. 48.

[170]Molnar, op. cit.

[171]Prior to the 1976 decision to adopt a modular design for the U.S. version of the Roland, as opposed to the Franco-German system which is part and parcel of their respective national vehicles (the AMX-30 and Marder chassis), the U.S. system was to be integrated into the Goer, a large wheeled vehicle. John Marriott used the shortcomings of this original plan as further ammunition to make his case in his article entitled "Has America Bought the Wrong Weapon?" wherein he questioned the U.S. decision to select the Roland II.

> One modification is to fit the system into one of their own vehicles, but this is proving more difficult than expected. The vehicle originally chosen was the Goer, a large, wheeled vehicle. However, the Goer is by no means popular with the U.S. Army and, if the well known columnist Jack Anderson of the Washington Post is to be believed, a test report on it states that it was rated as "at or near the bottom in every area tested".....
>
> The Goer is a high vehicle and to mount Roland II on it means that the weapon's surveillance radar antenna (which is not covered by a radome) sticks out like a sore thumb and would make an easy target for air attack, particularly as the rotating antenna tends to attract the eye, as does any moving object. Either a radome is required (more modifications) or a much lower and less conspicuous vehicle is required.

> In Europe, Roland II has been mounted in the German Marder vehicle and the French AMX30, both tracked vehicles with lower silhouettes and interiors of a very different size and shape to the Goer, or indeed any other U.S. vehicle.....

Marriott continued with regard to the requirement for mobility and the capability for helicopter lift.

> This dictates a small, lightweight, modular surface-to-air weapon. Roland II, as at present proposed, will be part and parcel of its vehicle, and, if a large vehicle like the Goer is used, a major air lift will be required, such as the C5A Galaxy.....
>
> All this is causing the U.S. authorities to think again. Roland itself weighs 8 tons and this dictates a large vehicle.....
>
> It would not be surprising if in the end the U.S. put it on a trailer, but the question must be asked why did they not think of all this when the evaluation was being carried out. Or did they and was the decision taken on political grounds?

[172]Marriott, op. cit., p. 79.

[173]Munro, op. cit.

[174]Aviation Week & Space Technology, June 6, 1977, p. 111.

[175]As with the RATAC project, waivers had to be obtained from ASPR requirements for audit and control of defense contractors. These waivers were eventually obtained for the U.S. Roland from the Comptroller General after a considerable effort in time and trouble.

[176]Norway, originally within Euromissile's territory, decided it preferred the modular design of the U.S. Roland fire unit instead. Norway was encouraged in this respect by a high ranking official in the DoD, with a major political storm resulting. The United States believed that one of the later amendments, one which granted the U.S. industrial team the right to manufacture Roland II for resale by the United States to third countries, subject to French and German Government approval, actually granted unrestricted rights, and therefore offered a sale of the weapon system to Norway. The misunderstanding was compounded by the fact that the French and Germans first learned of the error when the government of Norway announced its intended procurement of the system from the United States. However, an acceptable compromise was eventually agreed upon whereby Norway was transferred from Euromissile to U.S. territory. The compromise, while allowing the United States to sell the system to Norway, required that the United States procure the missile from Euromissile. (Aviation Week & Space Technology, June 6, 1977, p. 111.)

[177]As an example, there was no penalty prescribed for Euromissile's late transmittal of the engineering data to Hughes and Boeing.

[178]Ragano, "Giant Step," op. cit., p. 10.

[179]The U.S. Army required eight of these amendments, one minor amendment was requested by Euromissile (one which dealt with the bank to which payments were made) , and amendment #8 was superseded by amendment #9.

[180]Richardson, op cit., p.14.

[181]GRC, (1977) op. cit., pp. A-16 - A-17.

[182]Ibid.

[183]Ibid.

[184]Ibid.

[185]The superseded Amendment No. 8 allowed second-sourcing after low-rate initial production had been completed. However, it restricted the use by second-source bidders to the limited data made available to the prime contractor for his original proposal. The Army later recognized that such data restrictions would place limitations on their procurement process: limited data for the RFP, then full data to the second-source winner. Accordingly, in August 1976, they requested that the contract be amended again to allow the Army to use, with appropriate legal restraints, the data then in its possession for second-source procurement. This was incorporated in the superseding Amendment #9. A successful second-source bidder could then receive a sub-license from the U.S. licensees for manufacture of Roland. (GRC, August 1977, op. cit., p. A-16.)

[186]Ibid.

[187]Malone, op. cit., pp. 29-30.

[188] GRC (1976), op. cit., P. A-40

[189]Richardson, op. cit., p. 16-17.

[190]Ibid., p. 14-16.

[191]Ragano, "Giant Step," p. 10.

[192]Had the government attempted to force I^2 at a level below the missile round at that time, it was felt that the cost of backing up and starting over be too high. The rationale was that I^2 could be achieved at a lower level later, but TTF&T had to continue as started in order to minimize further disruption of cost and schedule.

[193]Ragano, "Giant Step," op. cit., p. 10.

[194]Ibid.

[195]Peacetime maintenance and repair are a slightly different matter, however, due to the U.S. Army's stringent requirements for high-reliability components. For immediate operational and readiness purposes a U.S. Roland may accept temporarily a European FRU, to be replaced later by the repaired U.S. FRU or with another U.S. FRU. The logistics of this approach have been under review jointly by all parties. The candidate list of FRUs will also indicate which units are exact equivalents to assist the logistics groups in establishing their system.

[196]Molnar, op. cit.

[197]Richardson, op. cit., p. 15. The RATAC project also involved "Americanization" in both these areas, safety standards for electronic components as well as the need to replace power supplies.

[198]Ragano, "Giant Step", op. cit., p. 12.

[199]Brig. Gen. Frank P. Ragano, U.S.A., "U.S. Roland - A Milestone in Technology Transfer," (hereafter referred to as "Milestone") Defense Management Journal, May, 1978, p. 7.

[200]Richardson, op. cit., p. 17.

[201]Ragano, "Milestone," op. cit., p. 10.

[202]Ibid.

[203]Col. Malone expanded on the problems facing logistics planning for the U.S. program.

> A difficulty facing logisticians in absorbing a 'technology transferred' system is that planning and design of maintenance equipment, and provisioning of spare parts, begin late in the total process. In the case of Roland this difficulty was compounded by the European maintenance philosophy which places greater reliance on factory support than is the case in the United States. Additionally, the Europeans lack the procedures, publications, and extensive Military Occupational Specialties planning of activities that characterize the U.S. logistics system. With regard to Roland, which was proposed with an Organizational Maintenance Test Set (OMTS), a Field Maintenance Test Set (FMTS), special tools, and a trainer, the FMTS which the PM expected to see in the data transfer just did not materialize. The Red Team report led to the United States developing a national FMTS—a task not priced out in the original bids—as the best course of action. Having to play catch-up ball in a technology transfer should be recognized as impacting on logistics staffing of the project. Fortunately for Roland, exceptionally well-qualified logisticians were given the catch-up task. (Malone, op. cit., p. 61.)

[204]During the technology transfer, a problem occurred with the radar. To expedite resolution of the difficulty, the Project Manager proposed a joint effort with the European contractors. The State Department Office of Munitions Control however, and some DoD elements were in agreement that such an exchange would constitute an undesirable export of U.S. technology. Therefore the joint effort was nixed.

[205]Ragano, "Milestone," op. cit.

[206]Ibid.

[207]Malone, op. cit., p. 40.

[208]Ibid., p. 6.

[209]Ibid.

[210]Ibid.

[211]Ibid.

[212]O'Lone, op. cit., p. 19.

[213]Ragano, "Milestone," op. cit., p. 10.

[214]Malone, op. cit., p. 48.

[215]Richardson, op. cit., p. 16.

[216]For example, magnetic device specifications lack much of the parametric detail required in the U.S.

[217]The E/M test procedures lacked pertinent information which was required to conduct tests due to greater reliance being placed on the know-how of specialists.

[218]For example, drawings of castings don't identify tooling points and as such aren't for numerical control machining.

[219]Ragano, "Giant Step," op. cit., p. 11.

[220]For example, drawings of castings don't identify tooling points and as such aren't for numerical control machining.

[221]Malone, op. cit., p. 106.

[222]Ibid., p. 73.

[223]Ibid., p. 71.

[224]Richardson, op. cit., p.17.

[225]Ibid.

[226]Lydia I. Pickup, Configuration Management During Technology Transfer paper presented by Ms. Pickup, a Boeing employee, at the Fifth International Conference of Women Engineers and Scientists, at Rouen, France, September, 1978, p. 2.

[227]Memorandum, January 31, 1978, on the subject of "Summary Report, Roland Program Representing Lessons Learned," by Gerry W. Magness, Boeing Aerospace Company, Seattle, p. 16.

[228]Pick up, op. cit.

[229]Ibid., pp. 2-3.

[230]Ibid., p. 3.

[231]GRC, (1977), op. cit., p. A-9.

[232]Trainor, op. cit., p. 37.

[233]Malone, op. cit., p. 47. The problem presented by this need to sort through this multi-standard base, moreover one in which practices and quality varied not only from country-to-country, but from plant to plant, were brought out in an example provided by Col. Malone. The use of the annotation "std finish," on a drawing for a hydraulic piston led to confusion as to which finish to use. The piston continued to malfunction until the standards interpretation error was discovered.

[234]Malone, op. cit., p. 69.

[235]Two examples of joint programs for which communications equipment was standardized on a national as opposed to international basis are the jointly developed MRCA Tornado and the license production in Italy of the USA/FMC M113 armored personnel carrier (APC). For the latter program, although the U.S. Army tried to get the Italian government to adopt the AN/VRC-12 series of radios being adopted for the US M113s, the Italian government opted instead to maintain national standardization through adoption of the GRC 3 through 8 series radios.

[236]GRC, (1977), op. cit., p. A-9.

[237]Ibid., p. A-10.

[238]The Italian M113 license production project provides us with an example of such an improvement originating from the stricter requirements of a licensee eventually being adopted by the licensor. For the M113 this involved track shoes.

[239]In some cases however, the reverse is also the case. An example cited in the Pickup paper was that of screws, nuts and bolts. Whereas in the U.S. a defense manufacturer will buy these items commercially, in Europe many manufacturers routinely have their own shops produce such items. Therefore, in this case European documentation would have more drawings than a U.S. manufacturer actually needed. (Pickup, op. cit., p. 1.)

[240]Magness, op. cit.

[241]Malone, op. cit., p. 68.

[242]Malone, op. cit., p. 67.

[243]See the sub-chapter on the F-16 project for some other implications of this phenomenon.

[244]GRC (1976) Vol. III, op. cit., p. 259.

[245]GRC Ibid., p. 260.

[246]GRC, Ibid., p. 260-1.

[247]Malone, op. cit., p. 71.

[248]GRC (1976), Vol, II, op. cit., p. A-18.

[249]Magness, op. cit., p. 16.

[250]See Aviation Week & Space Technology, November 27, 1978, p. 14-15, entitled, "Foreign Gains Threaten U.S. Lead."

[251]GRC, Vol. II, op. cit., p. A-18.

[252]Thomas M. Lindberg, "NATO Standardization - Fact or Fiction?," International Plans & Operations, Seattle, Boeing Aerospace Company, 1976.

[253]The Roland propellant employs tetryl compounds. Stringent Occupational Safety and Health Administration requirements on production of tetryl in the United States caused U.S. industry to discontinue use of tetryl compounds. United States producers of tetryl compounds faced the choice of either relearning the requisite processes or Roland would have to rely on remaining U.S. stockpiles. (Col. Malone cited this as an example of the basic truth that form, fit and function in and of themselves were not enough to maintain totally interoperable missiles. The same explosive and propellant chemistry was also required.) (Malone, op. cit., p. 74.)

[254]Melvin R. Paisley, Director, Boeing Aerospace Company's International Plans & Operations, transcript of speech given in the fall of 1976.

[255]Richardson, op. cit. This issue of the degree of testing called for by the particular case of implementation of acquisition procedures was at the center of the SEL-SHAPE dispute involving the SATCOM II Ground Terminal project, covered in Chapter 3.

[256]Ibid.

[257]Paisley, op. cit.

[258]A standard problem, this arose in the RATAC (previous subchapter) and the Boeing-Agusta CH-47 (Chapter 6, Mode #1) license production projects. Whereas in the RATAC case the U.S. prime contractor issued specifications for bidding, in the case the CH-47, the other alternative of recourse to direct purchase was adopted.

[259]Len J. Savage, BAC's U.S. Roland Materiel Manager responsible for the Fire Unit, PSE and European Procurement from 1975-1983

[260]Ibid.

[261]The author was the BAC U.S. Roland buyer for all Euromissile procurement for 12 months between mid-1981 and mid-1982

[262]Starting in 1982 the validity of a State Department export license was lengthened to 24 months.

[263]Erik Fromm, BAC, Legislative Relations

[264]Ibid

[265]Ibid

[266]Ibid

[267]Ibid

[268]Ibid

[269]Ibid
[270]Langereux, op. cit.
[271]Ibid.
[272]Ibid.
[273]"British Pressing Drive to Sell Rapier to U.S.", Aviation Week & Space Technology, October 8, 1979, p. 23.
[274]Ibid.
[275]"U.S.: Congress Backs Rapier," Defense & Foreign Affairs Daily, February 21, 1980.
[276]"USAF to Buy British Rapier," Aviation Week & Space Technology, March 2, 1981, P. 53.
[277]Aerospace Daily, March 15, 1982, P. 81.
[278]"United Technologies, British Aerospace Sign Rapier Agreement," Aerospace Daily, March 12, 1982, pp. 77.
[279]La Visite a Paris du Ministre Americain de la Defense, "Le Monde, October 16, 1981.
[280]Feazel, Michael, "U.S. 'Protectionism' Irks Germans," Aviation Week and Space Technology, January 19, 1983, pp. 16-19.
[281]Ibid.
[282]Ibid.
[283]"With Roland in RDF, NATO Requirement Remains", Aerospace Daily January 28, 1982, p. 140.
[284]Ibid.
[285]Ibid.
[286]"Maverick, Rapier Get Hill Attention," Aerospace Daily, April 27, 1982, p.333.
[287]Ibid.
[288]Ibid.
[289]Ibid.
[290] Kittle, Robert A. "Anatomy of a Pentagon Horror Story," U.S. News and World Reprot, October 15, 984, p.69.
[291]Ibid.
[292] Kozicharow, Eugene, "U.S., Germans Discussing 30 More Roland Systems" Aviation Week and Space Technology, August 6, 1984, p.25.
[293]Ibid.
[294]Ibid.
[295]Ibid.
[296]Hiatt, Fred, (Washington Post) "Pentagon Can't Afford Roland Missile, Can't Give it Away," Seattle Times, September 6, 1984, p.A12.
[297]Ibid.
[298]"Turkish Air Defense," Aviation Week and Space Technology, December 3, 1984, p.17.
[299]Kozicharow, Eugene, "Army Plans to Test Roland for Divad Role", Aviation Week and Space Technology, January 21, 1985, p. 22.

[300]Ibid.

[301]Ibid.

[302]Ibid.

[303]Lone, Richard G., "Roland Effort Tests Technology Transfer", Aviation Week & Space Technology, November 14, 1977.

[304]GRC (1977), Vol, A-11.

[305]Malone, op. cit., p. 106.

G. The U.S. Coast Guard's Selection of the Dauphin II for Its SRR Helicopter Requirement

On June 14, 1979, the U.S Coast Guard awarded its second major aircraft procurement contract to a French firm Aerospatiale. This award was for 90 of Aerospatiale's SA.366G Dauphin II helicopters to fill the Coast Guard's Short Range Recovery (SRR) helicoptor requirement. Aerospatiale received a five-year fixed-price contract for $215 million, having beaten out Bell Helicopter. The Dauphin IIs will replace the Coast Guard's Sikorsky HH-52A Seaguards, Sikorsky having withdrawn from the SRR competition several months earlier. The principal issues of import involved in this project center on the protest of the losing U.S. contestant to the GAO concerning the selection of a foreign system over a domestic one.

The contract was awarded to Aerospatiale Helicopter Corporation (AHC), a U.S. subsidiary of the parent French company. The helicopters are to be assembled at AHC's Grand Prairie, Texas, facility. AHC's president, C.J. Benner, claimed at the time that, based on the value of U.S. content, the Dauphin's delivered to the U.S. Coast Guard would be approximately 70 percent American.[306] As with other recent U.S armed services selection of foreign systems (the U.S Army's selection of the Belgian Fabrique Nationale armor machine gun, the Coast Guard's selection of 41 French Dassault-Breguet Falcon medium range surveillance aircraft, and the U.S. Army's selection of the German Rheinmetall 120 mm tank gun), there were immediate judicial/congressional repercussions as the interested parties, on the U.S. side that had lost, protested the decision.



a prime mission : perform them all

Leader in the 10-12 seat helicopter bracket, the Dauphin provides armed forces with the versatility so essential in any modern conflict over and above its unparalleled performance and technology. The missions it can handle are manifold :

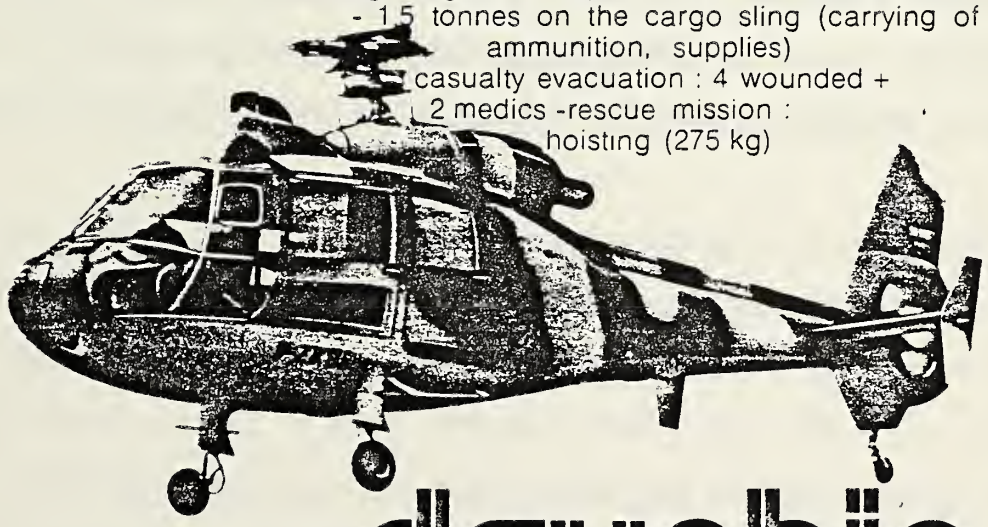
assault transport : 8-10 equipped commandos

anti-tank warfare (ATW) : 2nd generation anti-tank missiles (HOT type) - transport of ATW squad (Milan type)

close fire-support and armed reconnaissance : side-firing weapons (cannon) - axial weapons (machine-gun, rockets)

light logistic transport : 1.5 tonnes internal load - 1.5 tonnes on the cargo sling (carrying of ammunition, supplies)

casualty evacuation : 4 wounded + 2 medics -rescue mission : hoisting (275 kg)



dauphin

mission accomplished

aerospatiale

Division hélicoptères 2 à 20, avenue Marcel-Cachin - 93126 La Courneuve - France

A multi-mission aircraft, the SRR will have a sophisticated Rockwell-Collins avionics package including all-weather search, navigation and communications equipment. The Coast Guard plans to use the new aircraft for search and rescue, environmental protection, and marine science activities.

First delivery will be in early 1982, at a rate of one per month for the first six months and two per month thereafter. The new aircraft will eventually be deployed aboard Coast Guard cutters, including polar icebreakers, and at 19 Coast Guard air stations throughout the U.S. The SRR is equipped with twin Avco-Lycoming gas turbine engines which allow it to fly 165 nautical miles, hover 15 minutes, rescue up to three people and return.[307]

This contract represented one of two such awards in 1979 by the U.S. armed forces to a U.S. subsidiary of a European-based firm. The other case involved Fabrique Nationale's subsidiary in South Carolina, which will be producing the U.S. Army's armor machine. Although these two cases do not involve license production by a U.S. firm, they do involve second source production in the U.S. of a foreign system and represent a more recent variation within Mode #4.

Two weeks after the announcement that AHC was the winner on June 28, 1979, Bell Helicopter Textron, Fort Worth, Texas, filed a formal protest with the General Accounting Office, its first in more than 30 years of doing business with the U.S. government. Bell president, James F. Atkins, stated that Bell would "vigorously pursue its legal rights in this matter, and that it is seeking fair and equitable treatment under the provisions of the...contracting procedures and the laws of the United States."[308]

Atkins continued, stating that:

> Many other Americans must be troubled regarding the increasing lack of support from our government in assisting U.S industry to lead the world in technology and to develop export sales.
>
> Aerospatiale Helicopter Corp. is little more than a marketing operation... 100% owned by the giant French aerospace company, Societe Nationale Industrielle Aerospatiale, and is in turn an instrumentality of and controlled by the French government.
>
> Aerospatiale of Texas has a sales office and delivery center... reportedly totaling about 100,000 square feet, about 200 employes and a net worth of only about $350,000 as of January 1978. To this company the DOT (Department of Transportation, of which the Coast Guard is a part) awarded a $215 million contract. Its limited U.S. capability and meager financial standing makes the award almost unbelievable.[309]
>
> In effect, Bell Helicopter was really competing with the French government and its political and financial capability.

"On the other hand," Atkins pointed out, "it's been a long time since we've been invited to participate in a French competition."

According to Atkins, the Coast Guard's choice violated the Buy American Act in that Aerospatiale Helicopter would not be producing a "domestic source end product" as the act requires. Atkins stressed that the act was included in the contractual terms of request for proposals and the resulting contract.[310]

Under the Coast Guard's computations, the U.S. content of the Aerospatiale proposal would be 71 percent, but Bell felt very certain that the computation was in error.[311]

Atkins said "a close examination of the data...will indicate that the U.S. content, as defined by the Buy American Act, will be far less than 50 percent. Therefore, the DOT award would not be a domestic procurement and a factor of

$12 million should be assigned to the Aerospatiale bid. This would make Bell low bidder by approximately $11 million."

> After Bell's "unsatisfactory debriefing" on its loss by the Coast Guard, Atkins said, "DOT officials indicated that their preliminary review of the Buy American computation, while still leading to a domestic end product conclusion, was significantly lower than that stated by the Coast Guard..."[312]
>
> To the extent that an erroneous view of the law or regulations accounted for the 71% figure, which has apparently been abandoned, there is all the more reason for serious doubt as to the accuracy of the revised figure.
>
> Indeed, given the fact that the Coast Guard would be procuring what it and everyone else recognizes to be a French helicopter, it is inconceivable that, by any rational and realistic test, the French helicopter could properly be regarded as a domestic end product.[313]

Since a protest to the GAO does not automatically suspend work on an award contract, Bell Helicopter Textron filed suit one week later in the District Court, on July 6, seeking to overturn the contract.[314]

In mid-July, Bell submitted a 27-page protest of the Coast Guard's SRR decision. In the supplement, Bell asked the GAO to include a number of issues in its review of the Coast Guard's Buy American Act determination. Bell wanted the GAO to consider that,

> (1) A Possible Subsidy. The French government may in effect be "subsidizing" the sale of Dauphin II helicopters to the U.S. Coast Guard by permitting Aerospatiale of France to transfer airframes and other components to its American subsidiary at lower-than-cost prices and then recovering some or all of the difference in the subsidiary's apparent profit. A French subsidy, if substantiated by GAO, would have the effect of understating the foreign content of Aerospatiale's SRR model, Bell noted. "BHT believes that the Buy American Act requires that all costs of a component be considered even if these costs are not passed through to the procuring activity. The purpose of the Buy American Act is to prefer the use of American labor and materials in order to assist the United States economy. Thus, it is irrelevant whether the costs are eventually charged to the government. The true loss to the American economy through

procurement of foreign materials can be measured only by examining the actual costs, and not merely the costs passed along."

(2) Two Different Helicopters. The Coast Guard flight tested the Aerospatiale SA 365C instead of the SA 365N, from which the SRR helicopter would be derived, and that this violates the Coast Guard's request for proposals. Bell quoted an RFP requirement that the helicopter made available for flight evaluations "must be one from which the proposed SRR helicopter is directly derived." The RFP and the SRR selection plan made clear, Bell said, that the parent helicopter had to be available commercially, modified only as needed to perform the SRR mission. According to Bell it had complied by proposing a version of its Model 222. On the other hand, the Aerospatiale model that BHT (Bell) believes was flight tested by the Coast Guard was the SA 365C, was by no means the parent of the helicopter that would be delivered under the contract. The latter is not directly derived from the SA 365C, but from a later newly designed model— the SA 365N—which differs in major respects from the tested aircraft, including a rotor, transmission, landing gear, fuselage, power plants, controls, etc." Bell referred to the competition between its 222 and Aerospatiale's "'paper' aircraft" as an "apples-and-oranges comparison" that departed from the RFP, which "called for testing a parent—not a grandparent, an uncle, or a cousin."

(3) Substitution of Domestic for Foreign Sources. The apparent substitution of American equipment for some French components in an attempt to meet Buy American Act requirements also violates the RFP, Bell claimed, because the only modifications permitted were those needed to meet SRR requirements.

(4) Two Different Producers. "The SA 366 helicopter...will be assembled in an as yet non-existent Texas facility from a mixture of foreign and domestic components, whereas the SA 365C helicopter submitted...for flight evaluation was conceedly a French helicopter manufactured (a) by AHC's parent in France, (b) by an experienced French workforce, (c) at a long-established French manufacturing facility, and (d) from French components. In light of these fundamental differences, the SA 366 cannot reasonably be regarded as a direct derivative of the SA 365C as required by the RFP."

(5) Sight of Flight Evaluation. Bell noted that Aerospatiale made the flight evaluation helicopter available to the Coast Guard in France. The RFP provided that this be done "at offeror's facility."

(6) Impact on Foreign Sales. The Coast Guard's choice is essentially a French helicopter, despite a Transportation Department assertion that it is only 44% foreign. And Bell's ability to compete its 222 against Aerospatiale for "important future

export sales...may be severely impacted throughout the world if Aerospatiale is in a position to claim, however unjustifiably, that BHT's (Bell's) own government did not think highly enough of its helicopter to buy it."

(7) Consideration Only of Component Costs. The "primary error" in the Coast Guard's Buy American Act determination "appears to be the inclusion, as helicopter components, of...subcontracted services, as well as AHC-performed services and post-manufacturing items that are not components of the helicopters and are therefore not properly considered in a Buy American determination."

(8) Shifting Sources and Work Sites. Aerospatiale "apparently contemplates construction of a new plant in Texas for the eventual final assembly of components and also the development of domestic subcontractors for some components that are now of foreign origin. In view of the relatively short time allowed to meet scheduled deliveries under the contract, AHC may intend, or be forced by circumstances, to produce some of the initial helicopters or helicopter components in France, and later to substitute domestic assembly or purportedly domestic components."

(9) Spare Parts. Bell "believes...that the projected purchases of spare parts—which BHT estimates will amount to 20-25% of the $215 million contract price—were not considered" in the Buy American determination.

(10) Proper Definition of Manufacturing. "No one can seriously question that if the contract which has been awarded is performed, the Coast Guard will have purchased what is essentially a French helicopter... The inclusion of American engines and avionics and a few pieces of special equipment desired by the Coast Guard cannot be permitted to obscure the fact that the airframe, the true essence of the helicopter itself, is of French design and French manufacture. Nor does assembly work in the United States ...change its French manufactured character and convert it into an American helicopter any more than a Peugeot automobile would become identified as an American car if it were shipped from France to the United States for addition here of electronics and minor special accessories. Indeed, it would be at odds with the common understanding throughout the commercial aviation world to deny that the Coast Guard has selected a French rather than an American helicopter for its SRR mission."

Independently of this, GAO must consider the status of foreign components assembled in the U.S. "It is thought, for example, that AHC plans to use about $6 million of foreign gears in its helicopters, but that these gears may not have been regarded as foreign for purposes of the Buy American Act determination. If this is true, it may be because the foreign gears are diverted

> to an American subcontractor for installation in a housing before shipment to AHC... BHT believes...that the foreign identity of materials does not vanish for Buy American Act purposes simply because of contrived manipulation within the United States which does not really alter their basic nature or purpose." There may be other instances in which the Coast Guard made a similar judgment "because of similar contrived cosmetic work," Bell said.

In late August, the Justice Department filed a memorandum at U.S. District Court in Washington, D.C., in support of a motion by DOT, the Coast Guard's parent agency, to dismiss or obtain a summary judgment on Bell's move for a preliminary injunction against the contract.

The Justice Department said that the affidavits and depositions from Coast Guard and Naval Air Systems Comand officials that it had submitted to the court clearly demonstrated there was a rational basis for the award...and that there was no violation—not to mention a clear or prejudicial violation—of the applicable statutes, including the Buy American Act, or regulations in making the award. Additionally, the Justice Department asserted that the plaintiff lacked standing to make certain claims."[315]

In the principal Coast Guard affidavit filed, Capt. Howard B. Thorsen—head of the SRR project group and chairman of the Source Evaluation Board (SEB) for the system—said that although the SRR RFP required that the helicopter provided for flight evaluation "must be one from which the proposed SRR helicopter is directly derived, it did not have to be capable of meeting the SRR mission and performance requirements." The Coast Guard, he said, performed flight evaluations only of aircraft it judged as having the potential to meet the RFP's requirements.[316]

Elsewhere, Thorsen said that after best and final offers were submitted by AHC and BHT on May 25, 1979, the SEB found AHC's candidate "significantly superior" in mission capability and design quality.[317]

Arguing as an intervenor-defendant and seeking dismissal or summary judgment of Bell's suit, Aerospatiale said the facts of the case were not properly in dispute. The issue in Bell Helicopter Textron's lawsuit, according to Aerospatiale, is whether the Coast Guard has "a rationale basis" for technical and other determinations that favored Aerospatiale. In response to Bell's allegations that the proposal was judged incorrectly in some technical respects, Aerospatiale said that "it is not the role of the courts to superimpose their judgment for that of the contracting agency in areas where technical expertise is at issue... It is instead the province of this court to determine... whether the Coast Guard had a rationale basis for its finding that AHC (Aerospatiale) offered a system that is technically superior to Textron's."

Aerospatiale continued with regard to Bell's contention that the SRR helicopter will be essentially French, with only minor work done at the U.S. subsidiary's facilities at Grand Prairie, Texas. This is a complete and unconscionable distortion of the record. Systems integration will be at a plant being built for availability consistent with the contract requirement that production begin in January 1981. Bell's citation of Aerospatiale's current Texas facility as no more than a repair station is irrelevant because the contract will be fulfilled at the new facility.[318]

In late December 1979, the GAO rejected Bell's contentions that the Coast Guard had violated RFP requirements as to the extent to which a helicopter furnished earlier for flight evaluations could be modified for the SSR procurement; that AHC lacked the net worth, facilities and workforce to be a responsible bidder in view of "the apparent absence of any performance or financial guaranty" from Aerospatiale of France; and that use of U.S. indices in cost escalation provisions is improper to the extent that components and spare parts originate abroad.[319]

The GAO did find, however, that Bell Helicopter Textron was correct in asserting that the Coast Guard failed to implement the Buy American Act in the selection process that led to its award of the contract to Aerospatiale Helicopter Corp. In its decision on Bell's protest of the award, GAO agreed that the winning version of the Short Range Recovery (SRR) airframe—to be manufactured, tested and certified in France, disassembled and later reassembled in the U.S.—is, under the provisions of the Act, a "foreign-manufactured component."[320]

In response to the several charges, GAO

(1) Found that although it appeared that the Coast Guard should have added to AHC's offer the 6% differential required by the Buy American Act where a product is foreign-manufactured, the addition in this case would not have changed the relative costs of the BHT and AHC offers.

(2) Said that although the solicitation required that the proposed sale helicopter be directly derived from the aircraft submitted for flight evaluation, in this case the provision "when read as a whole indicates that intention was that the flight-tested aircraft have potential to meet agency's mission and performance requirements."

(3) Explained that GAO generally does not review protests against "affirmative determinations of responsiblity." The standard used, it said, "is much the same as that followed by courts which view responsibility as (a) discretionary matter not subject to judicial review, absent fraud or bad faith. Since protestor does not allege fraud, he has failed to meet the standard for review by GAO or courts."

(4) Called "irrelevant" the fact that price adjustment percentages to be used in price adjustment clauses are to be based on domestic indices instead of the ecomony of France, where some of the costs will be incurred.[321]

On the first charge the GAO response went into considerable detail.

> If the airframe's cost is more than 50% of the costs of all components of the helicopter end product, the helicopter is a foreign source end product, and the 6% differential required by the Buy American Act... and implementing regulations, should have been added to the foreign offer before offers were evaluated according to the technical/cost basis procedure in the RFP. Even though the addition of the differential would make AHC's cost proposal higher than Bell's...the technical advantage in AHC's proposal under the evaluation provided in the request for proposal outweighed the cost advantage.[322]

As part of a further explanation of how this case would be applied for future such projects, the GAO continued, "in order that an understanding will exist as to how the Buy American Act must be applied in a procurement like this," GAO noted that a clause in the Coast Guard RFP "advised prospective offerors that the award would be made on the basis of the proposal most advantageous to the Government, price and other factors considered, and cautioned that, because factors other than price would be given paramount consideration, neither the lowest fixed-price proposal nor a proposal meeting minimum requirements with the lowest price would necessarily be chosen if a higher-priced proposal contained sufficiently greater technical merit to justify the additional expenditure."[323]

The RFP, GAO said, listed three principal factors and their subfactors "in descending order of importance": technical/program suitability (mission capability, design quality, logistic support and test, demonstration and qualification program); cost (contract price, relative life cycle cost); and management.

The Source Evaluation Board (SEB) of the Department of Transportation orally rated the offerors' technical proposals on that basis and reported its findings orally and in writing to the Department's Source Selection Advisory Council (SSAC), which then applied numerical weighting factors to evaluate the proposals according to the same criteria.[324]

The addition of the 6 percent differential for a subcriterion worth 20 percent of the entire evaluation range would not be sufficient to overcome the difference in scores largely attributable to technical considerations.

Another section of GAO's decision dealt with Bell's objections to some 18 conclusions reached by the Coast Guard in its technical evaluation of the two proposals.

> The agency prefaced its detailed remarks on each of the contentions by observing that "the overall determination of the relative desirability and technical adequacy of proposals is primarily a function of the procuring agency, which enjoys a reasonable range of discretion in the evaluation... Since determinations as to the needs of the Government are the responsibility of the procuring activity concerned, the judgment of such activity's statement of its needs ordinarily will be accepted by our Office.
>
> Such determinations will be questioned by our Office only upon a clear showing of unreasonableness, an arbitrary abuse of discretion or a violation of the procurement statutes and regulations.[325]

"With these ground rules in mind," GAO then discussed each of the 18 contentions and said that in every instance DOT's evaluation was either "reasonable" or "not unreasonable."[326]

[306]Aerospace Daily, 6/29/79, p. 299.
[307]Armed Forces Journal International, 8/19/79.
[308]Aerospace Daily, 6/29/79, p. 299.
[309]Ibid.
[310]Ibid.
[311]Ibid., p. 300.
[312]Ibid.
[313]Ibid.
[314]Aerospace Daily, 8/27/79, p. 297.
[315]Aerospace Daily, 8/27/79.
[316]Ibid.
[317]Ibid.
[318]Aerospace Daily, 9/13/79.
[319]Aerospace Daily, 12/24/79.
[320]Aerospace Daily, 12/31/79.
[321]Aerospace Daily, 12/24/79.
[322]Aerospace Daily, 12/31/79.
[323]Ibid.
[324]Ibid.
[325]Ibid.
[326]Ibid.

H. The USN's VTX-TS Advanced Trainer Competition

One project that could potentially lead to yet another case of production in the U.S. of a European-designed and developed system is the USN's VTX-TS.

The U.S. Navy is currently considering new and existing candidate designs from both U.S. and foreign manufacturers for its trainer replacement requirement of an estimated 275-350 aircraft. Foreign bidders were required to have a U.S. partner. The list of teams submitting proposals has included:

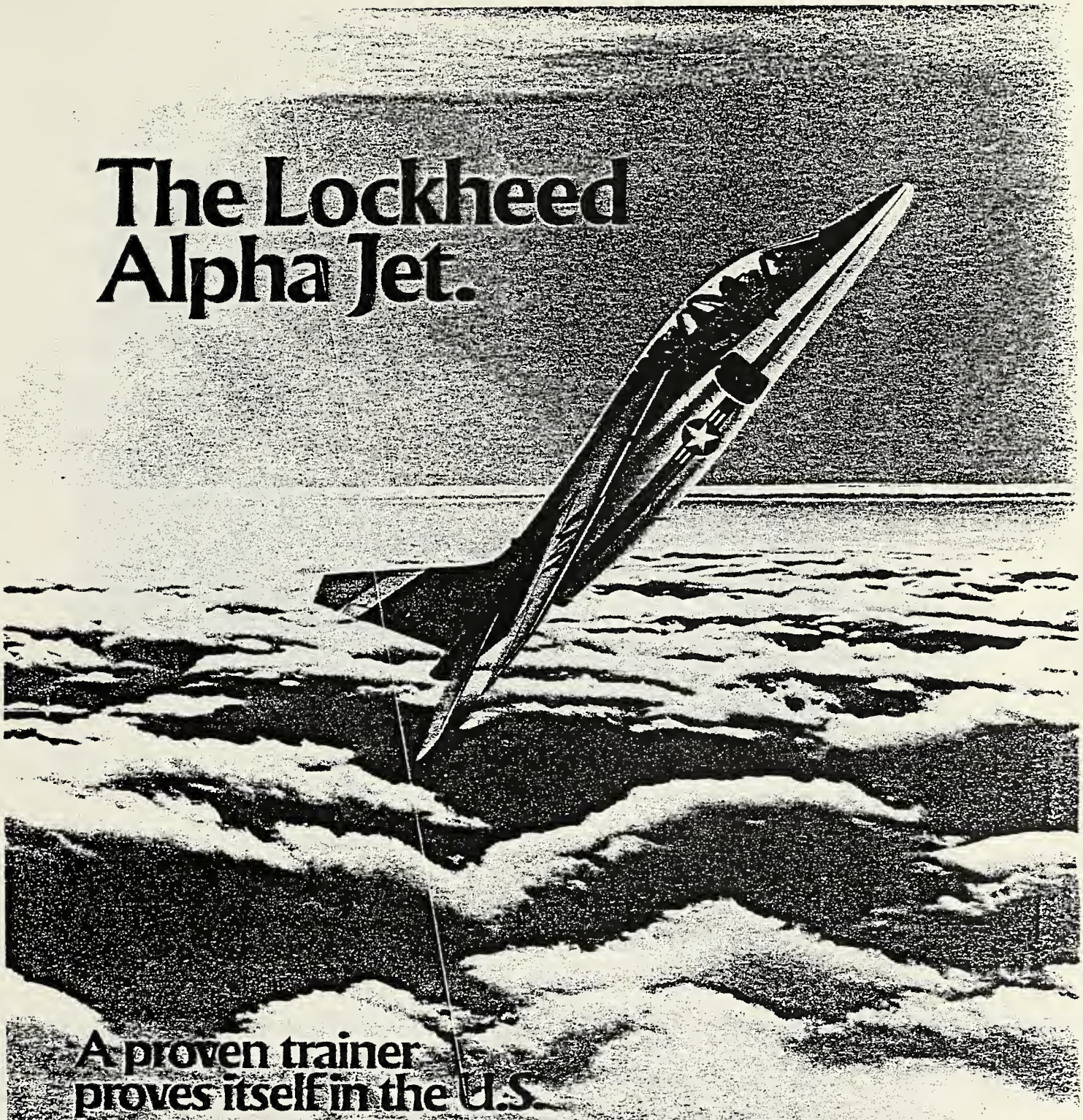
—Lockheed and Dornier/Dassault-Breguet for the Alpha Jet;
—McDonnell Douglas and British Aerospace for the Hawk;
—Grumman Aerospace and Beech Aircraft Corp.;
—General Dynamics and American Airlines; and
—Rockwell International

Italy's Aeronautica Macchi aiso evidentally intended to propose the MB.339, but had difficulty finding an interested U.S. partner.

1. VTX: Alphajet

After the Roland, the Alpha Jet trainer/ground support aircraft represents another major example of a system originally acquired through Mode #3 being a serious contestant for procurement by the U.S. armed forces through Mode #4.

The Lockheed Alpha Jet.



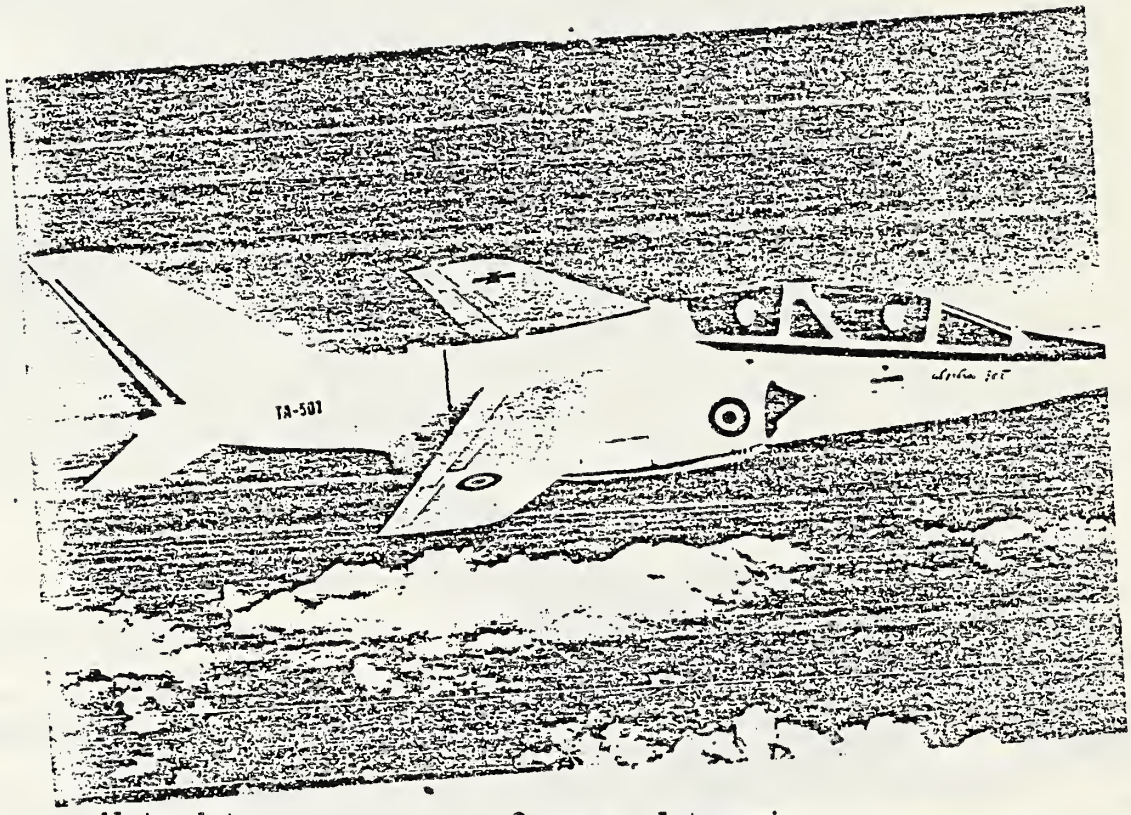
A proven trainer proves itself in the U.S.

Flight instructors at Navy and Air Force Training Commands recently put the Lockheed Alpha Jet through its paces and gave it high marks as a potential Navy VTXTS and USAF trainer. At the same time, Alpha Jet gave quite a demonstration of reliability. A single Alpha Jet achieved 99% availability, flying an average of five demonstration flights per day for 18 consecutive days. All told, 68 pilots flew Lockheed's Alpha Jet, grading it as an outstanding performer in formation flying, spins, air combat maneuvering, landing training, instruments and a host of other VTXTS requirements.

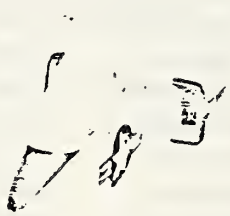
Exceptional flying performance is only part of the Alpha Jet story. It would save this country about $700 million in procurement and operating costs.

Alpha Jet. To be built by Lockheed in the U.S. Lockheed's training system can be graduating students into supersonic fighters and saving this country hundreds of millions of dollars by 1986.

Lockheed Alpha Jet
The proven performer.



Alpha Jet Source: Interavia



MacDac's VTX-TS Design

Source: Aviation Week and Space Technology

Lockheed teamed with the Alpha Jet developers, Dassault-Breguet of France and Dornier of the FRG, for the U.S. Navy's VTX-TS advanced trainer competition.[327] Designed as a land-based aircraft, a portion of Lockheed's participation in the teaming arrangement involved studies of the aircraft's adaptability for the Navy's carrier-based requirements. During mid-1979 Lockheed evaluated the aircraft during a series of test flights in France and the FRG. These flight tests demonstrated to Lockheed that the Alpha Jet was well suited for the Navy's requirements.[328]

The only significant change Lockheed envisioned for the Alpha Jet in the VTX role, beside the necessary modifications required to handle carrier launch and recovery and the addition of a new avionics package, is the possible modification of the wing to upgrade its stall characteristics.[329]

2. Hawk

The British Aerospace Hawk trainer is the other major foreign contestant in the Navy's VTX-TS competition for a T-2 and TA-4 replacement and involves a more complex multi-system teaming arrangement than that of Lockheed and Dassault-Breguet/Daornier. In February, 1980 British Aerospace and McDonnell Douglas signed an agreement to become joint contenders. The consortium's proposal to the USN for an advanced concept training system was to include two alternative aircraft designs, one of which included the navalized version of the Hawk. In the second, an entirely new aircraft was to be designed and developed by McDonnell Douglas to incorporate advanced technology. Somewhat along the lines of an earlier work sharing arrangement reach between McDonnell

Douglas and a U.S. partner, Northrop, for the F-18, whichever firm has its design selected will obtain approximately 60 percent of the work with the other partner receiving 40 percent.[330]

If the USN wants an initial operating capability (IOC) of 1986 the two companies will propose BAe's Hawk.[331] If the USN chooses the Hawk, BAe would be the prime contractor during the initial stages of the bidding program, with McDonnell Douglas providing assistance in integrating the aircraft into the overall training system and in engineering modifications needed to meet U.S. Navy requirements. Once the Navy gives the production go-ahead, MDC would become the prime contractor, building the system under license from BAe at the Douglas aircraft facility at Long Beach, California. In addition to being licensor, BAe would be the principal sub-contractor.[332]

If, on the other hand, the USN decides an IOC of 1989, McDonnell Douglas would propose a new aircraft design. McDonnell Douglas would design the aircraft and be the prime contractor for both development and production, with BAe as its principal subcontractor.[333]

The carrier-compatible Hawk would have these changes:

- Modified and strengthened main landing gear, capable of accepting touchdown rates of 20 fps.
- New design dual nose gear capable of accepting catapult hookups and launches.
- Arresting hook on the aft fuselage.

- New avionics suite, including possibly a heads-up display. The aircraft will also have the option of a cockpit display compatible with such future combat aircraft as the McDonnell Douglas/Northrop F/A-18.[334]

[327]Jeffrey M. Lenorovitz, "Redefined Alphajet Eyed as VTX Entry," Aviation Week & Space Technology, August 6, 1979, p. 38.

[328]A memorandum of understanding signed by the three companies allowed for the teaming arrangement to be dissolved if it was determined the aircraft was not adaptable for the VTX role.

[329]Lenorovitz, op. cit.

[330]David A. Brown, U.S., Britain Plan Joint VTXTS Offer, AWST, Feb. 18, 1980, p. 61.

[331]As of March, 1979, 100 of the 175 Hawks ordered by the RAF had been delivered.

[332]Brown, op. cit. p. 61.

[333]"More Details on BAC/McDonnell Douglas Hawk Deal," Interavia Air Letter, No. 9417, January 14, 1980, p. 3.

[334]"Carrier-Compatible Hawk Modifications Detailed," Aviation Week & Space Technology, April 16, 1979, p. 16.

I. The Leopard 2 Evaluation by the U.S. Army

After a duration of seven years, the Main Battle Tank for the 1970's (MBT-70) project collapsed in 1970, with the FRG and the U.S. each going their separate ways.[335] The U.S. continued for a another two years with a scaled down version of the MBT-70 in the form of the XM-803, while the FRG upgraded its independent backup effort for a follow-on to their Leopard tank, designated the Leopard 2.[336]

The first phase of the Leopard 2 was kicked off in 1967 with the development of two experimental prototypes, both of which were delivered to the Bundeswehr and the BWB in December 1970, eleven months after the MBT-70 project was cancelled.[337] In January, 1973, the U.S. Army as well made a fresh start with the formal launching of its XM-1 tank project. Meanwhile the Leopard 2's second phase of development had progressed to the point of delivery to the BWB of the first of a batch of 17 pilot tanks.

As the U.S. Army was moving towards its XM-1 solution during 1972, it began eyeing with curiosity the Leopard 2 as a potential competitor for the planned Chrysler and General Motors XM-1 designs. Consequently the U.S. Army purchased a Leopard 2 chassis in 1973 for intensive mobility testing at its Aberdeen Proving Ground. Subsequent analysis of these tests of the developmental prototype led the U.S. Army to conclude that the Leopard 2 fell short of their requirements.[338]

Meanwhile, starting in 1972, dialogue had once again begun to pick up within NATO's Eurogroup, and then later on a transatlantic basis, focusing on the

economic and military advantages offered by greater standardization and interoperability of weapons used by the NATO allies. Along with this discussion came the demand that the U.S. begin to adopt a policy of greater reciprocity (i.e. more of a two-way street) in considering the acquisition of European systems, not just promoting standardization on U.S. systems as had been a natural tendancy in equiping the European allies during the 50s and 60s; first through 'in kind' grant aid, then licensed production, and ultimately direct sale (the latter often accompanied by offsets). Economic and technological development in Europe had by the early 70's progressed to such a point that the earlier U.S. lead in many areas of conventional weaponry had been substantially eroded. Consequently a new equilibrium among the very sovereign NATO allies would tend toward greater reciprocity.

In spite of the U.S. Army's unfavorable conclusions on the pre-production Leopard 2 in 1973, development of an improved version of the Leopard 2 was planned to begin the following year. With the political and economic backdrop described above, overtures to Secretary of Defense James Schlesinger from German Minister of Defense Georg Leber at the June 1973 meeting of NATO's Defense Planning Committee, led to negotiations aimed at the introduction of the Leopard 2 as a formal contender in the U.S. Army's M-60 replacement program, alongside Chrysler's and General Motor's XM-1 prototypes.

Leber's original suggestion that both countries standardize the main guns of their new tanks led, after subsequent meetings and correspondence, to a counter-proposal by Dr. Schlesinger that the FRG "study how the Leopard 2 could be modified, with minimum design impact, to meet U.S. performance and

cost constraints." He concluded his September 28, 1973 letter stating "I feel that the efforts I have discussed should lead toward greater standardization, especially in the main armament, and even possibly toward a final evaluation that one of the tanks could meet the needs of both of our armies." The FRG agreed, and the U.S. Army was assigned responsibility for negotiating a Memorandum of Understanding and then managing the project.[339]

Negotiations progressed during 1974 toward the signature of a bi-lateral MOU which would lay out the plan for an evaluation by the U.S. Army of the Leopard 2 as a possible candidate for its next generation main battle tank. By the fall, agreement was reached, and the two countries' Defense Ministers signed the MOU at NATO's December Defense Planning Committee meeting.

Following the signature of the MOU, the FRG was given the desired performance characteristics for the XM-1, including ballistic protection goals, plus the project manager's evaluation of the Leopard 2 chassis which the army had tested earlier.[340]

This information was passed on to Krauss-Maffei, the developer of Leopard 2, which set out to modify its tank to an Americanized version now known as Leopard 2 AV. Modification to the Leopard 2 would include special armor, a new turret, a greater fuel reserve for longer range, less track vibration, a cooling system with greater capacity, and a simpler, less expensive fire control system (FCS).[341]

This later change, to the FCS, would involve the replacement of the German EMES 12 FCS with one from Hughes Aircraft Company, the YAG laser rangefinder sight FCS.

As for armor, in the late 60s a new type of armor offering greatly improved protection over conventional armor had been perfected in the U.K. The United States had become aware of the theory of chobham armor but elected not to attempt to incorporate it into either the MBT-70 or XM-803 because of transfer restrictions and other reasons. Approval for commencement of the XM-1 program in January 1973 made it economically and technologically feasible to incorporate this advance into the new tank design. With the December, 1974 accord between the U.S. and the FRG, the same armor was to be incorporated into the Leopard 2 AV.

The agreement with the FRG was intentionally vague as to whether the German tank would be selected after evaluation. The agreement referred to "all reasonable efforts to achieve maximum standardization" of the XM-1 and the Leopard.[342]

Basically the MOU led to a two pronged effort. The most ambitious one involved the modification of several prototypes of the Leopard 2 in the FRG, followed by test and evaluation in the U.S. as part of the runoff with the XM-1. The second and more far reaching prong was initially a low-level backup effort; exploring the feasibility of mounting of the German 120 mm gun on the XM-1.

FMC Corporation was selected to be U.S. manager of the Leopard 2 program and ultimately the manufacturer to produce it under license, if selected. FMC was awarded a contract by the XM-1 project office on 22 July 1975, to prepare a producibility/cost study of the German tank. The contractual agreement also stipulated that U.S. would fund 50% of the producibility/cost study and the FRG the other 50%.[343]

FMC was scheduled to initially release the document in June 1976, with a final updating of the cost of producing the German Leopard 2 tank in the U.S. for the end of the year. The producibility/cost study plan is shown on the following page, along with the related DSARC schedule. The American industrial group supporting this study included: FMC for the tank system integration, hull and turret weldments, track and suspension, automotive subsystem; Hughes Aircraft Corporation would handle the turret integration and the fire control; Teledyne Continental Motors the engine, transmission, fans and radiators.[344] A more detailed explanation of work breakdown is shown in the following chart.

As all this activity was underway with the Leopard 2 AV, four of the unmodified Leopard 2s from among the total of 17 were shipped to North America for additional climatic tests. These took place at Canada's Camp Shilo in February and March at -35° and -40° Celcius, and at Yuma, Arizona in April and May at +45° Celcius. Observers from the U.K. and France, as well as the host nations, were also present for the accompanying artillery and fire control system demonstrations.[345]

As 1975 progressed, the visibility of the U.S. Army Leopard 2 AV evaluation picked up as it became linked with negotiations over the funding and work sharing associated with the acquisition by NATO of a force of USAF/Boeing E-3A Airborne Warning and Control System AWACS aircraft. As the FRG was to have the largest among the European shares in paying for the aircraft, the Leopard 2 became tied in by the Germans, not only as a potential external offset, but as a symbol of the willingness of the U.S. to acquire European systems in return for their acquiring a U.S. one.

The modified Leopard was to be evaluated against the same performance and cost constraints as the U.S. prototypes, and preferably on a simultaneous basis. It soon became apparent, however, how difficult it would be to wrestle the parallel efforts into sync, i.e., constructing a new Leopard 2 prototype that incorporated all the required changes would take longer than estimated, and the Leopard would not be available in time for side-by-side testing with the XM-1 prototypes.

In discussions between the two countries, the FRG stated its position that side-by-side testing of the three candidates should be delayed until September 1976 when the modified Leopard would be available. The United States felt though, that waiting 7 months to initiate the first phase of XM-1 development and operational testing was out of the question. Consequently, the Army proceeded with plans to put the XM-1 into full-scale development leading to initial production in 1979, once source selection had been completed. Two different Congressional conference committees subsequently supported the Army when proposals by some members to defer full-scale development until after side-by-side testing with the Leopard 2 were defeated.

On November 6, 1975, the German equivalent of our USDR&E, Hans L. Eberhard, wrote to DOD expressing concern over the U.S. Army's requesting authority to select an XM-1 prototype and enter it into full-scale development three months before the Leopard would even begin testing.

Apparently, the FRG had not realized that the Army intended to commit funds, at least initially to the development of the winning U.S. tank.[346]

Therefore, while the FRG backed up in order to modify the Leopard 2, the Army's XM-1 program proceeded on schedule. Prototypes developed by Chrysler and General Motors were tested in early 1976 at Aberdeen Proving Ground, with announcement of the winner scheduled for July 1976.[347]

The winner of the XM-1 competition, however, was not announced in July 1976 as scheduled. That month the Memorandum of Understanding between the two nations was amended to include specific efforts to standardize tank components. The selected components were the engine, transmission, gunner's telescope, a night vision device, the fire control system, the tracks, and the main gun. Chrysler and General Motors were awarded contracts to prepare proposals for incorporating these components (also planned for the Leopard) and to redesign the tank turret to accommodate a 120mm gun. In November the Army selected the Chrysler prototype for full-scale development, while the Leopard was still finishing up its testing at Aberdeen.[348]

The three modified Leopard 2 test units had meanwhile been delivered to the U.S. Army's Aberdeen Proving Ground on schedule and were formerly accepted on

September 9, 1976. Though simultaneous testing of the Leopard 2 with the two competing XM-1 prototypes would have been preferable, the lack of it was generally considered not to be a critical impediment.

A tank's performance is a function of three major characteristics: firepower, mobility and protection. Although there are a wide range of opinions as to the relative importance of the three, the U.S. and British Armies tend to place their highest priority on survivability through armor protection, whereas the German and French approach this objective through emphasizing mobility.

After the Aberdeen tests had been completed, the Army Materiel Systems Analysis Agency (AMSAA) reported that the Leopard met all U.S. mobility requirements, and that test results showed both tanks were about equal in firepower. AMSAA's conclusion was that the Leopard met or could meet, with major modifications, nearly all of the Army's critical survivability, mobility, and firepower requirements. The XM-1, too, as with any prototype failed to meet all requirements and would itself require substantial modification.[349]

The crucial difference between the two tanks seems to have been the relative vulnerability of the respective armors. The protection offered by the Leopard's chobham armor was not, according to the AMSAA findings, equal to that of the XM-1. AMSAA's report offered two possible reasons:

- Differences in how the two countries perceive the threat.

- The haste with which the type of armor used on earlier versions of Leopard was modified to the special armor.

AMSSA's report complimented the FRG armor technology and inferred that with more time the difference in armor protection could have been narrowed and perhaps eliminated.[350]

Another issue for the U.S. Army centered on the probable delay in the initial operational capability (IOC) date for its new generation MBT, if the German tank was the one selected. The Army claimed another full-scale development effort would have to be initiated which would include the production of 11 more prototypes of the modified version of the Leopard 2 over a 36 month span, in order to demonstrate that the modified Leopard had overcome the shortcomings of the earlier version. The FRG maintained that its experience in developing and modifying the Leopard already demonstrated performance sufficiently so as not to require the full scale development program.[351] This debate was by no means a new one, either within the U.S. government or between allied governments, i.e. the concept of phased or step by step acquisition (with substantial testing along the way, which was the current U.S. DoD policy) versus assuming the risks of concurrency in order to speed up development.

In this regard the GAO report stated that "it is at least questionable that the Leopard should have been handicapped in evaluation because the XM-1 might possibly be available sooner."

In addition to estimates as to eventual availability, there was also that of estimated cost. In 1972, in accordance with the design-to-cost concept being introduced in DoD, the Army set an average unit hardware cost goal of $507,800 for the XM-1. This design-to-cost constraint was a recognized objective that the Leopard had to meet.

The GAO did not obtain comparable costs in comparable dollars for each tank, but the Army placed the unit cost of the XM-1, using a 30-per-month-production rate, at $728,000 in 1976 dollars. This was $56,000 less than FMC's estimate of the Leopard's cost .[352]

FMC, as the prospective American licensee for the Leopard 2, came to the conclusion by the end of 1976 that realistically the Leopard stood little chance of acceptance and, therefore, it was unwilling to incur the considerable cost involved in preparing a proposal for full scale engineering development/producibility engineering planning. Appropriated funds to pay for a proposal from FMC were not available. FMC's views reflected a feeling persistent in some quarters that, despite Army statements that it would choose the Leopard if it proved clearly superior to the XM-1, the Army would not select such a prestigious weapon as a tank which was not developed in the United States.[353]

As they entered the new year, however, the March 1977 schedule for a decision on which tank it would adopt, had still not been called off. On January 5, 1977, the then XM-1 project manager reiterated to a GAO team that DoD and the Army were still prepared to select the Leopard as its new main battle tank if it proved the most cost effective as the result of the comparative evaluation.[354]

Later in the month, three weeks after the completion of the trials, the U.S. and the FRG negotiated an amendment to the MOU terminating the plan to evaluate the Leopard. This particular stick of political dynamite had been defused. Later that spring an additional amendment was negotiated covering the list of candidate subassemblies in the two tanks for standardizing, though, with the exception of the possibility that the U.S. might adopt the 120mm gun, little was expected to come of it.

A year later in January 1978 the U.S. Army did select the German 120mm tank gun for incorporation in M-1 series production tanks from the mid-80's on. The gun was to be produced under license in the U.S. at the Army's Watervliet, N.Y. aresenal. See Chapter 11 for more details on this arrangement. Though the tank gun should logically be covered in this chapter, as it too involves production in the U.S. of a European system, it was inserted in Chapter 11 because of its also being caught up in the overall effort of the DoD to satisfy German offset demands centering on their 29% share of the NATO AWACS project, as had the full-blown Leopard 2 evaluation before it.

The GAO report on the Leopard 2's evaluation by the U.S. Army concluded as follows:

> We believe that had the Army's evaluation of the two tanks gone forward, the status of the XM-1 program would have probably been as it is today--that is, considering their close comparability the Army would have selected the XM-1. In retrospect, however, it is probable that in view of the international interest surrounding this acquisition and the Army's long attachment to the XM-1, it might have been wiser to limit the Army's role by placing the Leopard's testing and its comparative evaluation with the XM-1 under the direct control of the Office of the Secretary of Defense. In our opinion, this would have assuaged much of the concern that the Leopard would not receive fair consideration.[355]

> Moreover, when foreign weapon systems are being considered by a military service, it may be not only appropriate but necessary for the Office of the Secretary of Defense to be involved in the evaluation process. There are considerations beyond which a single military service cannot cope. This view is reinforced by statements from West German officials that the decision on the Leopard could have a bearing on the Government's financial capability to purchase the Airborne Warning and Control System from the United States. The sale of this system is outside the Army's responsibility.[356]

There simply isn't any way to avoid the broader inter-allied political implications for a weapons acquisition decision of this magnitude. The removal of the Leopard 2 from the running was not the end of it. The Leopard 2's 120 mm gun picked up where the tank versus tank evaluation ended. Following the selection and agreement on license production of the 120 mm gun which was completed in January of the following year, some 10 1/2 months later in December 1978, the FRG agreed that they had received adequate consideration in the offset area and could fund their share of the NATO AWACS. The U.S. Army will receive an excellent tank gun for its out-year M-1's, interoperability of a vital weapon system amongst the NATO armies will be increased, and the NATO AWACS project was finally off the ground after 3-1/2 years of negotiations. Though the high visibility and inevitable controversy made for rough going, and it took a considerable amount of time for all the ducks to be lined up, eventually a mutually acceptable set of agreements was in place.

Now we see that the original MBT-70 joint development project resurfaced, (with the Leopard II's consideration by the U.S. Army), and ultimately the German tank gun was adopted for the M-1. Two other U.S. license production projects treated in this chapter resurfaced in another form at a later date: Sperry's production of two Dutch HSA WM/22 fire control systems lead nowhere immediately but the U.S. Navy was back several years later with license pro-

duction on a large scale of the HSA WM/28; and a similar fate awaited the British Kestrel/Harrier series of fighters.

The synchronizing of the two national acquisition processes proved itself to be a major hurdle for this project. Not only were the comparative systems at different stages of development, which created timing problems, but the need to compensate for this by off-setting estimates and risk factors further clouded the evaluation. Moreover, the more evolved German system had to be hastily modified so as to meet U.S. Army requirements different from those it was originally designed to, plus incorpoate more recent technological developments. The tailoring of one national system to that of another is always risky business especially when they are two such outfits as the U.S. Army and the Bundeswehr with their long traditions, and highly developed but differing ideas as to what makes for the ultimate tank.

Given the above environment, how far will a contractor go in committing its resources to support a dark horse, and someone else's at that. In contrast, the Short Range Air Defense (SHORAD) system evaluations and competition of the 1972-74 timeframe involving the British Rapier, French Crotale and Franco-German Roland all involved advanced developmental prototypes or early low-rate production models where risk was no doubt involved, but the only U.S. design competing was that of a paper system, an all-weather version of the Chaparal which would involve the development of a virtually new system. Therefore, not only were the foreign systems at roughly comparable stages of development, but the only U.S. one was years behind them.

The U.S. Roland project history provides us with examples of some of the problems that are faced once a foreign system overcomes some of these initial hurdles and is selected, with the technical data package being transferred to the U.S. and converted for the reproduction of a modified version.

[335]See Chapter 10 for the history of this joint design and development effort.

[336]The Leopard I was itself the product of a broken home, along with the French AMX-30, each of which emerged from the aborted Franco-German tank project dating from 1957-63 time frame (see Chapter 8).

[337]The Leopard 2 as well, incorporated several important MBT-70 subsystems, but of German origin, and was thereby able to benefit from some four years of trials under the earlier program. Chief among these were: the MB 873 Ka-500 engine, the HSWL 354 transmission; the friction damper and track systems.

[338]Department of Defense Consideration of West Germany's Leopard as the Army's New Main Battle Tank, Report to the Congress by the Comptroller General of the United States (PSAD78-1) November 28, 1977, page 1 (hereinafter referred to as GAO Report).

[339]Ibid., p. 3.

[340]Ibid.

[341]Ibid.

[342]Ibid.

[343]G. M. Bailly-Cowell, "MBT Leopard 2 AV for NATO?", NATO's Fifteen Nations, June - July 1976, p. 23.

[344]Ibid., p. 30.

[345]Ibid., p. 23.

[346]GAO Report, op. cit., p. 5

[347]Ibid., p. 4.

[348]Ibid., p. 6.

[349]Ibid., p. 9.

[350]Ibid., p. 8

[351]Ibid., p. 9.

[352]Ibid., p. 10

[353]Ibid., p. 11

[354]Ibid., p. 11.

[355]Ibid., p. 15.

[356]Ibid.

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